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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE
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256 BROADWAY, NEW YORK.

Some Leading Articles in this Number.

How Twist Drills are Made.
A Trip from London to Fastnet Light.
Reducing Gear for Indicators.
Building a Great Dynamo.
Action of the Series Motor.
Education and Invention.
Variety of Letters from Practical Men.

NINETEENTH. YEAR.

No. 23.
June 4,
1896.

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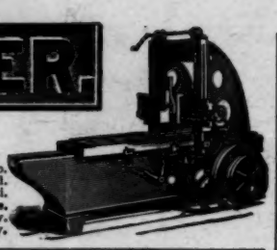

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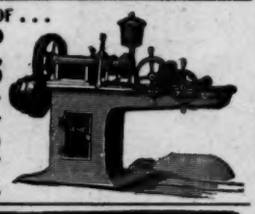

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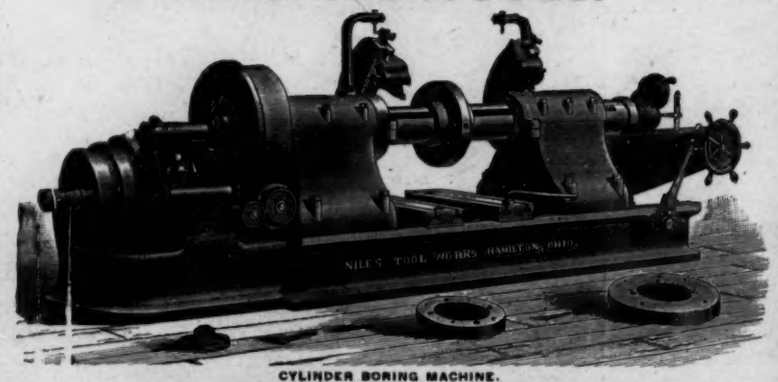

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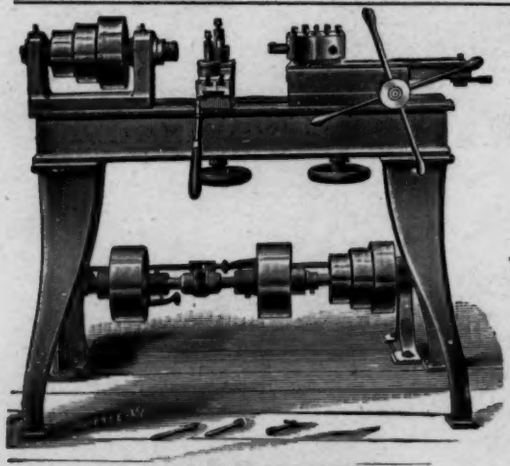

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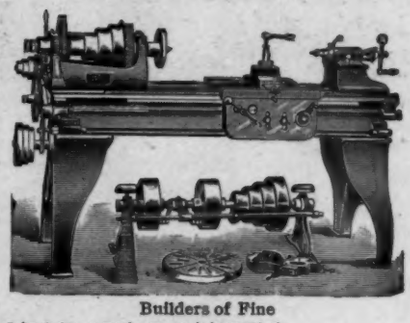

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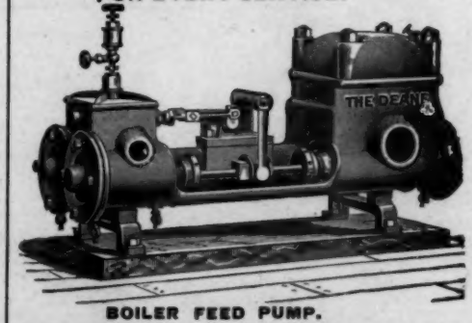

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AMERICAN MACHINIST

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Twist-Drill Making and Other Operations at New Bedford.

It is easy for the older members of the fraternity of machine constructors to recall the time when that now common necessity of machine shops, the twist drill, was unknown, and a machinist having a hole to drill, first skirmished around among a lot of miscellaneous flat, forged drills of all imaginable forms and sizes except the right ones, and finally either selected something not quite right, and used it, or spent as much time as would now be required to do the whole job in visiting the tool smith and in bending over an eccentric and erratic grindstone, trying with indifferent success to hold a pair of hinged calipers in his mouth and at the same time swear with sufficient fluency to do justice to the situation.

An important change in machine-shop methods was initiated when Stephen Morse, a machinist who had worked previous to 1864 in various lines of machine work, including locomotives and machine tools, conceived the idea that the twist drill, home-made forms of which he had previously seen used in various shops, might be made a regular article of manufacture, and took steps which led to the establishment of the business at New Bedford, Mass., now known as the Morse Twist Drill & Machine Co., whose buildings cover nearly an entire city block, and will probably soon be enlarged to meet a constantly increasing demand for tools with which nearly every machinist in America is familiar and that are beginning to be generally appreciated abroad—a single foreign shipment of drills, taps, reamers, etc., weighing about one and a half tons, having been made a few days before the writer's visit to New Bedford.

Every machinist who has used a Morse drill naturally wishes to know something of the methods by which such a tool is produced, and if he should visit these shops and be privileged to go through them, as the writer was privileged by the kindness of President E. S. Taber and Superintendent J. A. MacGregor, he would find many interesting operations, but not much of the mysterious—that is to say, the operations as now carried on there in making tools, are for the most part the natural and obvious ones that would suggest themselves to good mechanics, and success is attained more by careful selection of material, and care and skill in handling it, than by special or peculiar methods. In fact, the Morse tools are made by a force of employés who are evidently highly intelligent; they work with machinery and tools of high grade, in shops that are neat, clean and well lighted, and the work is done under highly skilled and specially experienced supervision—conditions which always and everywhere produce the best possible results, and are, in fact, absolutely necessary if the very highest results are to be obtained in any manufacturing operations other than the crudest and simplest.

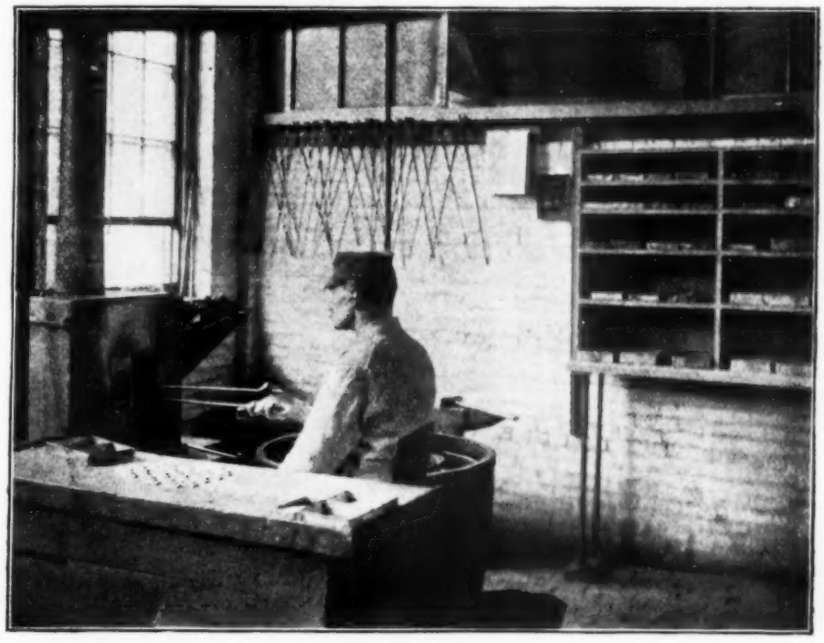

Fig. 1. HARDENING DRILLS.

Steel, most of which is English, but some American, comes in bars of the usual form, about 60 tons being usually kept in stock, on racks which facilitate the ready selection of any desired bar.

When wanted, the steel goes to a group of cutting-off machines of the usual form, and the pieces thus cut to length are then annealed in Brown & Sharpe furnaces, three of which have recently displaced the ten which formerly did the annealing, with better results so far as the work is concerned, and, as the man in charge of them stated to me, using exactly one-half the amount of anthracite coal formerly required for the same work.

A small forge shop equipped with trip and drop hammers besides the regular forges, does such forging as is required on pieces that, when finished, have widely varying diameters, and where, therefore, the steel is worth saving—the stock being in some cases upset to form the larger portion, and in others drawn down to form the smaller parts.

HARDENING AND TEMPERING.

Though nearly last in sequence of operations, the hardening and tempering operations are allied to the smith shop, and may as well be described here:

In these operations, if anywhere, we might expect to find some mysterious practices, but in reality we find nothing of the kind—only good equipment and a high grade of skill, the result of careful study and of long experience, and not to be acquired by any other means.

No single method of hardening is followed, but, instead, there are at least three methods in use on drills alone, and perhaps others on other tools.

One method that is used on quite small drills, up to about $\frac{1}{16}$ inch diameter perhaps, is to hold a dozen or more of them

in wide-jawed tongs, and then to place the tongs in a small furnace which burns charcoal, and in which a blast directs a flame through an opening into and across a small firebrick channel just large enough to easily receive the tongs. The operator sits in a chair before this furnace, and simply holds his group of drills, and keeps moving them about in this flame in such a way as to get an even heat, and then quenches them in salt water. It is a matter of skill acquired by practice, and the man works in a good light and in comfortable, clean and neat surroundings; such an operation is shown in Fig 1.

Another method which I saw used with somewhat larger drills, (about ¼ inch diameter), was to hold them in much the same manner and dip them into a lead bath; the lead being properly heated.

Still larger drills are heated in a bath of common salt. All the quenching is done in brine, the strength of which is tested frequently and kept uniform, and it is kept in circulation throughout all the quenching vats and tubs by a small pump, which takes it from an overflow tank and pumps it, through suitable pipes, to the tubs again, the main reservoir being outdoors. This arrangement helps in keeping both the strength and temperature of the salt water uniform.

Other tools I saw being hardened by simply placing them in a furnace on top of a bed of coal, over which and quite close to it was a slab of fire-brick, which becomes heated and confines the heat to the space in which the work is placed.

Experienced steel workers will perceive that there is little mystery about the hardening operations, and the temper-drawing methods are equally simple. A tank is provided which will hold a bushel or more of tools; this tank has tallow in it, and is placed on top of a furnace and arranged to be rolled on tracks to or from an opening through which the heat comes. The tank is covered, and a mercurial thermometer, immersed in the melted tallow, indicates when the proper temperature has been reached. Tallow is used simply because when melted it is very fluid, and is purer than sperm or other oils usually are.

As to what the temperature is, and supposing the Morse Company were willing that figures should be given, they would be misleading unless applied to precisely similar tools, made of the same steel, hardened in the same way, and it would therefore be useless to give them here. It is found by experience that these thermometers will change somewhat in use, and they are tested frequently in boiling water, and their errors noted and allowed for. Sometimes they are found to be off as much as 6 or 7 degrees.

For hardening thin saws (milling cutters) they are using a development of a device which has been illustrated and described previously in these columns, and consists of a hollow cylinder of cast iron, placed vertically and with its ends closed. The upper end is faced off true, and there are some vertical guide bars rising above it which guide the vertical motion of a similar hollow cast cylinder which has its lower face tooled true. This upper cylinder is arranged to fall upon the heated saw placed upon the lower cylinder; and as both cylinders are kept cool, the saws are thus hardened and at the same time kept flat and true.

TURNING DRILLS.

Drill blanks that are to be turned to size are centered at the upper end only, the other end being made conical in form to suit the angle of the lips that are yet to be, and this end is run in a female center. For twist-drill turning, lathes are used which are much the same as ordinary engine lathes, but the head and foot stocks are placed upon a swinging plate, which is pivoted at the center of the bed and has upon it the inside shears to which the head—and foot—stock are fitted.

These lathes were designed by the Morse Twist Drill Machine Co., about the year 1868, and most of them, I think, were made long before the Slater taper attachment came into general use; but as by this method tapers can, of course, be accurately turned with the centers in line with each other, it is a very satisfactory method, though I noticed that more recent lathes are made in the usual way and have an improved form of the taper attachment referred to. Some provision for turning tapers satisfactorily is very important in this work, for on drills there is really very little strictly cylindrical turning done, the body of the drill decreasing in diameter slightly as it approaches the shank, for the sake of clearance.

In all other respects the lathe work is done precisely as it is done in all other manufacturing operations where many pieces just alike are to be made, a lathe being kept at the same cut until all the pieces of the lot have been put through that operation; dogs are changed while cuts are running, and one man usually runs more than one lathe, the number depending upon the nature of the cuts he is making.

GROOVING DRILLS AND REAMERS.

Reamers are grooved usually by a gang of three cutters which are placed upon an arbor in a milling machine of the ordinary type, and there are three blanks which are side by side in a triple—center fixture fastened to the platen. Special index plates give the proper divisions for the flutes, which in all Morse reamers are varied to prevent chattering, but yet are symmetrical and systematic—i. e., each tooth has another one precisely like it, exactly opposite to it, and each half of the reamer is exactly like the other half; or, in other words, a group of flutes of decreasing width and depth extends just half way around the reamer, and then a precisely similar group occupies the other half of its circumference.

In the reamer department a curious reamer was noticed which is called in the shops the "French reamer." It is used very largely by bridge builders and other structural iron and steel workers, for reaming holes for the reception of the rivets or bolts when erecting, and when it is found that the previously drilled or punched holes do not line with each other. There is often a pretty heavy cut to take out under such circumstances, and little disposition to devote very much time to taking it. Experience showed that the ordinary reamer would not stand such work, and the reamer, a section of which is shown by Fig. 2, is therefore now made for this purpose in sizes from ¼ inch to 2½ inches. A very unusual amount of taper on the end enables the reamer to be entered in a hole which lacks very much of "matching," and the blank half of its circumference steadies it, while the very strong form of flutes in the other half enables the reamer to stand what would be abuse of any other tool of its class. The reamer is of course used by hand and has a taper, square shank for a wrench.

Fig. 3 shows another form of reamer now being made in these shops and found to be satisfactory as an adjustable reamer; one of its particular points being that it can as readily be made smaller as larger, which is by no means the case with all adjustable reamers. The six blades of this reamer pass through suitable slots and rest upon a taper pin at the center, which pin is threaded near its outer end for adjustment, and the beveled ends of the blades tend to force them down to their places when the nut at the end is tightened.

Drills are grooved in two different ways—the larger sizes in machines which hold the blanks in a socket at the upper end of a vertical spindle, which is fed upwards and at the same time revolved to give the twist by suitable gearing which is located below, while a cam and suitable lever connection simply lifts this spindle and the blank to give the "increase twist;" this lifting motion being in addition to the regular vertical feed motion given by the gearing, which latter gives what may be called the "normal spiral." The blank passes through a bushing, and there are two cutter spindles, one on each side and set at the proper angle, the cutters reaching the blank through openings in the bushing. There are hundreds of drill grooving machines arranged in long rows, the photograph Fig. 4 showing those used for the smaller sizes of drills.

These machines, two rows of which are shown in Fig. 4, hold the blank in a horizontal position and mill only one groove at a time, the spindle which holds the drill being provided at its rear end with a large cam in which a groove is cut that is the right pitch for the groove in the drill. It is at first difficult for one to convince himself that it is right, however, because

the cam, being a cylinder about 4 to 6 inches diameter, while the drill it is intended for may be considerably less than $\frac{1}{16}$ inch diameter, the angle of the spirals in the cam and in the drill differ so very much that they do not look as though they bore any relation to each other. Girls operate these machines; and each girl keeps from four to twelve machines in operation, working piece-work.

A beautiful new machine for grooving very small drills has been recently designed and built here, in which a novel method has been adopted for the vertical adjustment and movement of the cutter. Instead of the usual knee, the frame of the machine is extended out under the platen and its slide, and the spindle is arranged to be moved a short distance up and down in the housings by having its boxes inclosed in eccentric sleeves, which are connected together by an arm extending from one box to the other around the cone pulley. This arm rotates the eccentrics together and thus raises or lowers the spindle and is provided with suitable stops for exactly replacing the cutter at its former depth, when for any reason it may have been raised. When in operation the eccentrics and bearings are bound tightly and solidly by suitable clamping screws.

HIGH-SPEED MILLING.

In backing off or milling the clearance in drills, I saw milling done here at far higher speeds than I ever saw elsewhere, and much higher than milling-machine men usually consider possible. The job is done in two different kinds of machines, the larger drills being relieved on both sides at once by two cutters on spindles diametrically opposite each other, while the smaller ones are done in a small bench machine in which the drill is placed in a V-groove, held down by a finger which is at the end of a lever, and shoved along horizontally through the groove by another lever which carries a plunger somewhat smaller than the drill, which pushes it along in front of the milling cutter, while a stationary pin, engaging with the groove in the drill, rotates it for the spiral.

The cutter is cylindrical in form, about 2⅛ inches diameter, lapped to fit its spindle very closely, accurately ground, and revolved at 800 to 900 revolutions per minute, or at a speed of 445 to 500 feet per minute. Practically no lubricant is used, and in fact none at all for the cutter, but the drills are oiled slightly so that they will pass through the fixture easily and not wear it excessively.

The pains taken to get the cutters absolutely true, and the high speed at which they run, enable the drills to be shoved along in front of them with great rapidity; and yet the surface milled is very smooth, and the example is a good illustration of the truth of what has often been said in these columns—i. e., that no set rules can be laid down for speed of milling cutters. The proper speed depends upon circumstances and must be determined by good judgment guided by experience. In this case we have the conditions of a very light cut to be removed from thoroughly good and uniformly soft steel, no single cut lasting for more than a second or two. This applies to small drills only, the larger ones are milled at slower speeds, but still at what would be regarded as very fast ones.

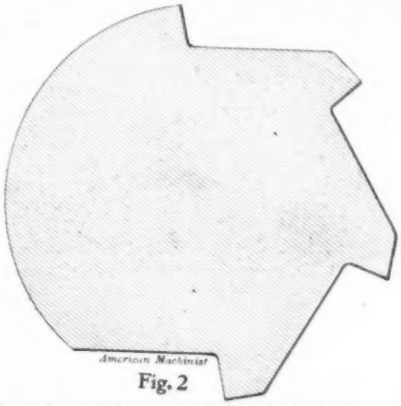

Fig. 2

SECTION OF FRENCH REAMER.

GRINDING LIPS.

Another example of the employment of training, and of skill of eye and hand, is seen here in the operation of grinding the lips of twist drills. They are first ground before hardening, as there is considerable steel to grind away, and it can be done more rapidly and without fear of injuring the drill by heat, as would be the case if it were tempered. After tempering they are again ground into final shape on the end, and both these operations are performed entirely by hand on emery wheels, the eye of the operator being the sole gage for the operation. Of course, these men do nothing else and are highly-trained specialists in this line. The results are sufficiently accurate for all practical purposes, and anyone who sees the operation performed by them will be ready enough to believe the statement of Superintendent MacGregor to the effect that no machine could possibly do them nearly so fast or materially better.

REVERSED GRINDING MACHINES.

Noticing several Brown & Sharpe universal grinding machines here having their head and foot stocks transposed upon the platen, Mr. MacGregor explained that this had been done because it had been found that in grinding reamers it is important that the wheel should strike each "land" at the back edge instead of at the cutting edge, as is the case where the head-stock is at the left. It has been shown that a reamer ground carefully to fit a ring gage will be too small for the same gage when backed off if it has been ground in the usual way, whereas if it is ground in the reverse position, i. e., so that the wheel will strike the back edge of each "land" first, it will still fit the gage after being backed off. This shows that there is a certain amount of yielding each time the wheel strikes the work, and that the effect is to reduce or "dub off" the edge which the wheel first strikes.

This practice exactly agrees with that of John Spiers, who used to operate a universal grinder in Springfield, O. He ground a great many reamers of all kinds, and, noticing this tendency to grind the advance edge of flutes below size, arranged a small driver which he attached to the face plate of the machine, and arranged it to engage with a tooth of the reamer for driving. This enabled him to get the same result without transposing the head and foot stock, and he demonstrated that a reamer thus ground was in reality slightly relieved, since it would, when new, readily cut without being backed off at all, whereas when ground in the ordinary way it would bind and refuse to cut until backed off. There is no doubt whatever that butt mills and similar boring tools that are not usually relieved at all, are much better ground in the reverse position, as it gives them a slight relief, and the difference in the working of them is usually very plainly perceptible.

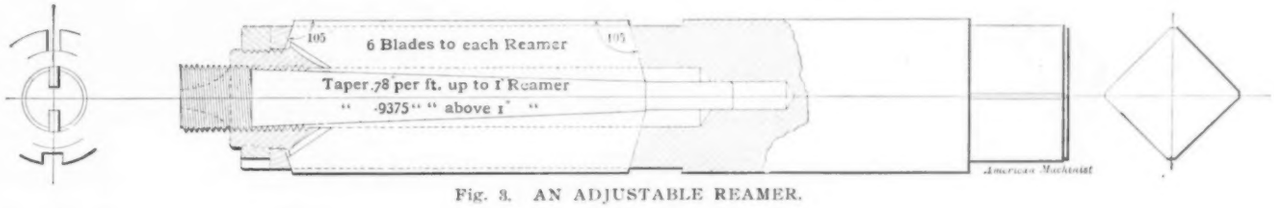

Fig. 3. AN ADJUSTABLE REAMER.

STRAIGHTENING DRILLS.

There are a great many mechanics who seem to think that it is perfectly practicable to harden such a tool as a twist drill without springing it, if only one could learn the secret of it, and they think that such establishments as this possess that secret. A view of the department in which the straightening is done would speedily remove that erroneous idea.

Here we see a long bench with windows in front of it, facing the north. In front of each window sits a man who does nothing but straighten twist drills that have been sprung in the hardening operation. The bench is divided into as many compartments as there are men and windows, by partitions which extend across the bench between the windows, so that each man gets light only from his own window, while back of the row of men is a high

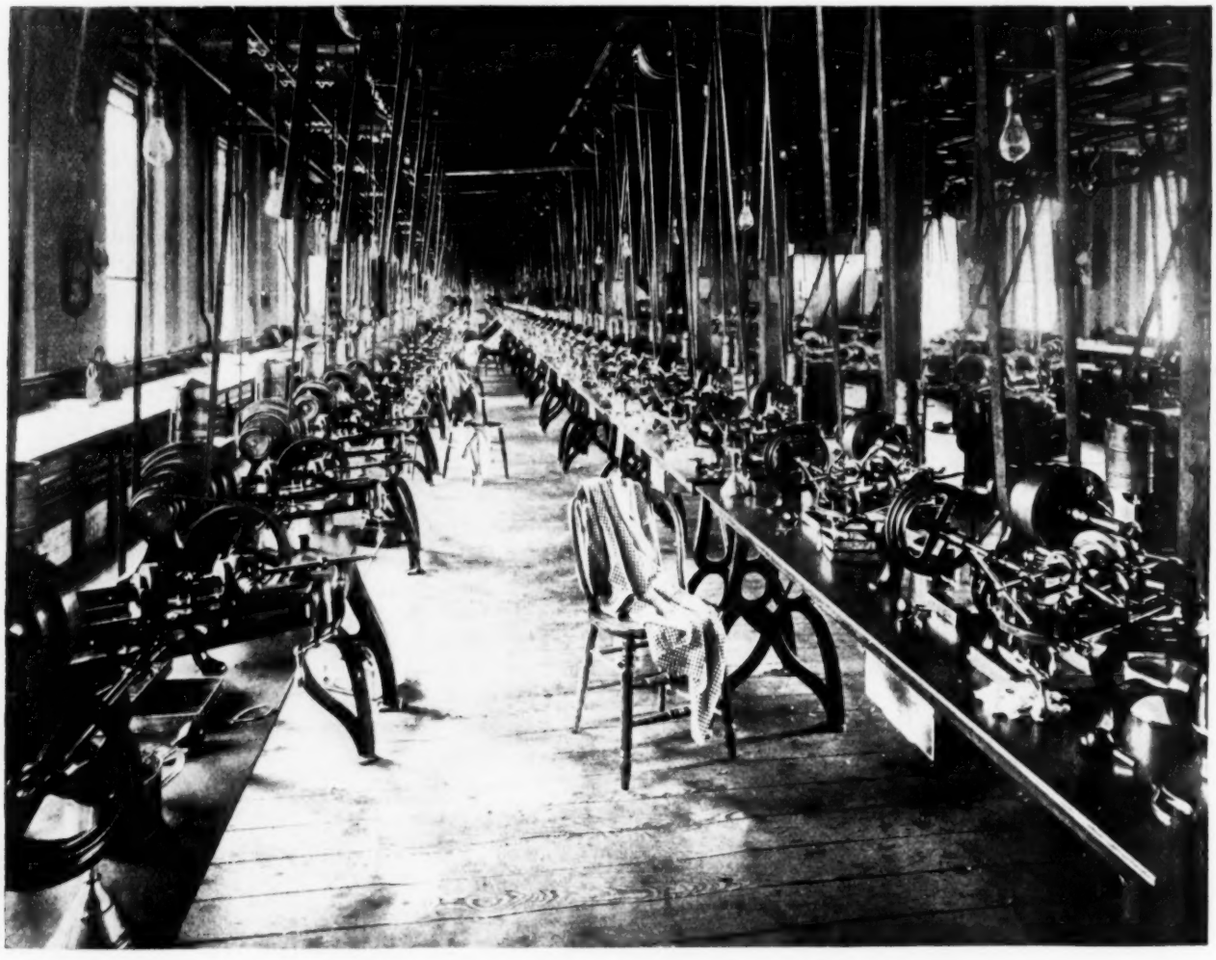

Fig. 4. DRILL-GROOVING MACHINES IN THE MORSE SHOP.

and dark-colored screen which shuts off light from the windows on the opposite side of the room.

On the bench, in front of each man and about on a level with his eyes, is a surface plate, and at the back of this surface plate, standing between it and the window, is a small frame which holds a sheet of semi-transparent white paper. The operator rolls a drill upon this surface plate, and looks under it at the sheet of white paper. His trained eye tells him where the crooks are, and his experience tells him their extent and how much pressure it will take to straighten them out. This pressure he puts upon them by means of a small press which stands upon the bench at his left, first warming that portion of the drill which is to be subjected to it by means of a Bunsen burner which is near the press and blazes only when the man presses a lever with his foot.

Three kinds of presses are used here for this purpose, the one for the larger drills being a plain screw press with a hand wheel at the upper end of the screw. A quicker one also uses a screw as its principal member, but the screw is turned by means of a pair of bevel gears, which enables the operator to work it by a lever which moves in a vertical plane, like a drill-press feed lever; while a still more rapid press used on very small drills has a plunger in place of the screw, and this plunger is operated by a cam which is on a shaft operated by a lever working in the same manner. The end of this plunger is fitted with a triangular-shaped plate, and in the platen below it is a shallow depression, similar in shape, but somewhat larger. When a short kink is to be taken out, it is placed under the plate near the apex of the triangle; while if the bend is longer, it is placed further back. The whole operation and the apparatus for it are thus seen to be very simple; but it is one involving a great deal of special skill, which can be acquired only by practice, and not by every man who tries it, even with unlimited practice.

Drills having taper shanks are first straightened throughout their grooved and tempered portions, and are then inserted in the end of a spindle fitted to receive the shanks and revolved the same as they would be in a speed lathe. The operator then notes whether or not the end of the drill runs true, and if not, he then springs the drill at the juncture of the shank with the body, knowing of course that the shank itself and the body are both true and straight within themselves.

INSPECTION FOR STRAIGHTNESS.

Every drill made must pass some sort of inspection, and the method of testing small drills for straightness is very simple, but at the same time ingenious and effective. An idea of it will be gained from the sketch Fig. 5, in which *a* is a small plain steel plate, under which and near the ends are placed two drills *b b* of the size to be inspected. Under these drills are strips of paper, the thickness of which paper represents the limit within which the drills must come as to straightness in order to pass inspection.

The plate *a* is clamped down upon the two drills *b b*, and the space thus left between the plate *a* and the surface below

it is equal to the diameter of the drill plus the allowance. The whole device is inclined about as shown, and the drills are allowed to roll through under the plate *a*, being started in at *c* and emerging at *d*, where they fall into a box placed to receive them—that is to say, they do this if they are nearly enough straight; but if not, then they stick under the plate and are forced upwards out from under it again by the movement of a trigger-shaped piece of sheet brass, which is pivoted near one corner of the plate *a* and held out of the way when not in use by a spring.

It is not pretended that the above is a full and complete description of all the work done in this establishment, but it

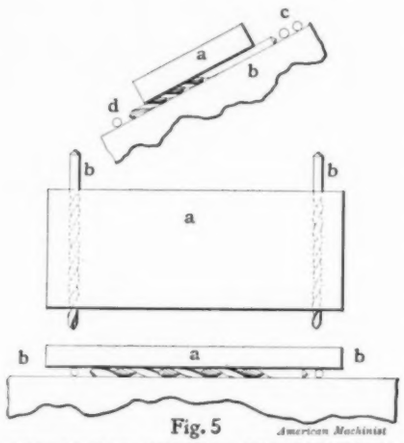

Fig. 5 *American Machinist*

DEVICE FOR TESTING STRAIGHTNESS OF TWIST DRILLS.

will serve to give drill-users some idea of the pains taken in making good drills. Probably nothing is done here which has much of the element of secrecy or of mystery about it; and the operations are of that nature, often met with in manufacturing operations, which may be seemingly exactly duplicated elsewhere, but will not produce the same results unless there is also the special skill which comes only with experience.

It should be said also that, while this description applies to the Morse factory as it is operated to-day, changes are constantly going on as improved methods of doing the work are devised, and it is expected that a number of such changes will take place within the next few years.

M.

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A Trip from London to Fastnet Light.

BY W. H. BOOTH.

I doubt if ever a letter has been written to the "American Machinist" from this place where I am now staying. The journey here from London—a distance of 600 miles—takes about 22 hours' continuous traveling; and as one gets further into the wilds, the means of travel become more and more simple and primitive. Leaving London by the crack train, the celebrated Irish mail, with all modern adjuncts of sleepers and mail vans, Holyhead is reached in 6 hours, about 2:30 in the morning, and another 4 hours by a fast paddle steamer takes one to Kingstown. Then the best train in Ireland takes one to Cork, and from Cork a smaller train carries one to Skibbereen, a little town very much in the fields. Beyond Skibbereen a steam tramway for 15 miles runs chiefly by the roadside to a still smaller place named Schull; but as there are only about two trains daily, we took a car for the 30 miles between "Skib," as it is termed, and Crookhaven. At Crookhaven the last half-mile is by a cable with water in it, out of which we hold up our feet. It would be impossible to describe the desolation growing denser every mile of these last 30 miles. Crookhaven lies just east of Brow Head, the western corner of Ireland, and the country is mountainous and rocky, and on the rocks there is next to no soil, the huge bowlders sticking out everywhere; and what adds to the scenic grandeur is the extreme and varying angle of the strata, which incline in every direction and from the horizontal to the vertical angle, or even overthrown. The rock itself is of the oldest, probably Silurian, and the whole district is as bare, rough and bleak as it is possible to imagine. Deep-cut inlets run far into the land between high ridges of rock, and one has to make long detours round these havens to get beyond them.

Every American who has come to Europe must have seen Brow Head, with Lloyds Signal Station on top, and, near to it, the Fastnet Lighthouse—a white tower standing on a pinnacle of rock which juts up out of the Atlantic about 80 feet, and except in the calmest weather is surrounded and lapped by a boiling, seething caldron of foam, which dashes high up the rock and even engulfs the lantern itself in moderately rough weather. Onto this Fastnet rock it was my object to get. The mode of landing is peculiar. From the side of the rock projects a long jib, which reaches out nearly horizontally over the sea. From it hangs a rope with a loop in it. The loop is hung down to the sea; your boat is rowed under it; and you step into the bight of the rope, seize the rope with your hands, and trust the rest to the men on the rock who haul you up into the air, above the foam if possible, and swing you round until they can drop you on an elevated platform of rock. Needless to say, this is not an experience that comes to one every day, nor one which many people care to undertake.

The rock stands fully 8 miles off shore, so is well out in the open ocean and exposed to the full fury of the Atlantic, and it is not possible to land except on the calmest of days; and to relieve the lighthouse men is often a matter of weeks in winter time. This little town ashore of Crookhaven had at one time several hundred inhabitants, but telegraphs have made it of far less account than it once was as the place where the ships put off all the American news for Reuter's; and there are not now more than 150 people—if that—and the place is of the smallest dimensions, there being only a few fisherfolk here. But the haven forms the headquarters of the fisher fleet from the Isle of Man, over 200 miles away, and it strikes one as peculiar that fishers can come so far and make it pay to fish off here, whereas the local people do so very little. The French, too, often come in here. Last night the only boat that ventured out brought in 80 dollars' value of fish. To-night there have gone out ten boats. In Scholl Harbor lies the "Jason," a warship to look after the fishery, but that is the one sign of authority about. At night, the haven being landlocked and free from anything more than a ripple, there is not a sound to be heard except an occasional voice. There is absolutely nothing to do but read or write, and I doubt if there is so absolutely lonely a place in all America; for this place, to a Londoner especially, is more lonely and desolate than if there had been no one here at all. Half the houses roofless denote a time of greater business, and this intensifies the feeling that is produced by such absolute quiet. Waiting in such a place for the wind to drop, while work is waiting for you at home, is not the most exhilarating pursuit, unless you are absolutely indolent of disposition. The geology is too mixed to be capable of complete comprehension; the flowers are numerous and of interest; the fauna comprises chiefly the fowl and the pig, and it is curious to see how the fishermen here make a buoy from "piggy." They just skin him, and tie up his arms and legs, and so on, and there is your buoy—simply a pig made watertight.

Though it is only since yesterday we have been here, it seems like three months, and we are stamping impatiently, much to the surprise of the natives, who spend their time propping walls and cannot understand our impatience. The first day after our arrival there was too much west in the wind to permit of the slightest possibility of landing, but it appears to be veering round to the north, and to-night (Saturday, since the following was written) it has gone to the north—and we had a day sufficiently calm to make an attempt to land. The mode of operation is first to secure a small fishing schooner, and with a fair wind we ran out in a little under two hours, and lay to a couple of hundred yards from the rock, where we took to our small boat, and by this means we were able to lie out a short distance only, but out of the surf. The lighthouse men threw off a buoy, and this we secured, and by means of its rope, which was attached to the head of the 60-foot jib, or derrick, we pulled this out from its position against the side of the rock, so that

it hung right over us. This done, the men at the winch lowered the rope into the boat, and one by one we stepped into the swinging loop, and seizing the rope with our hands, were committed to the air. It is simply magnificent, traveling in this way between the boat and the rock. Above towers the rocky eminence, crowned by the white tower with its crystal top, and the rock sides are rough and rugged in the extreme. Below you boils a green and white mass of mixed foam and water, and all around there are eddies and torrents, caused by the breaking of the swell upon the rock and by the rush of the sea between the main rock and Little Fastnet, a few yards separate. It is really impossible to describe the scene with any adequacy, it is so absolutely unique; and while you are trying to take it all in—the rock, the sea, the little boat fast receding, the sunlight and the huge tower above all—you find yourself already being lowered upon the landing platform, whence you climb upwards by steps cut in the rock, or made up of Portland cement; for a good deal of work has been done, by way of solidifying and reinforcing the rock, to make it proof against the ocean's fury. It is only safe to climb about with rubber soles, and in places they throw down a long rope from above, which gives a better security in creeping cat-like along the ledges of rock. It is only when you come to do this that you begin to realize the proportions of the rock; but even then it is a mere speck in the ocean, as many readers of the "American Machinist" no doubt have seen for themselves.

A few hours completes all the work that we can do, and we leave the rock as we entered upon it, by means of rope and jib, and get back to Crookhaven again and a diet of fish; for we are out of the world here, and only vary our diet by sometimes catching our own fish, and at others consuming that caught by the fishermen. But the work done, I hied me back to London gradually, ascending the scale in the method of travel as we approached London.

The light on the Fastnet Rock is an oil lamp with a series of circular concentric burners, alternating with annular air spaces. When lighted, there appears a solid mass of bright flame. At a distance of about a yard is an octagonal lantern, each side built up of a composite lens; and the whole octagon is slowly revolved so that, to all observers, when a lens comes into place and lies squarely across the line of sight, there appears a flash at that instant, preceded and followed by a gradual increase and waning; and there are eight such periods per revolution. The lantern revolves on friction rollers and slowly. Oil is stored in iron tanks, and there is a store of cartridges which, in thick weather, are fired at five-minute intervals, the explosion being audible for miles, especially in thick weather, when sound carries so well. The 18th April will always remain a red-letter day of remembrance to me by virtue of this most interesting visit, absolutely without parallel. Indeed, I suppose the rock may be set down as the most inaccessible inhabited part of these Islands.

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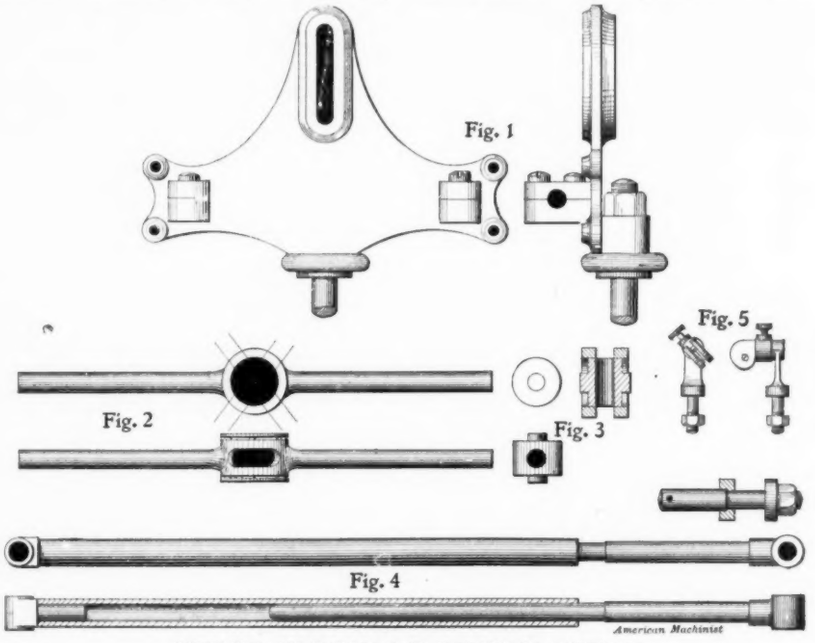
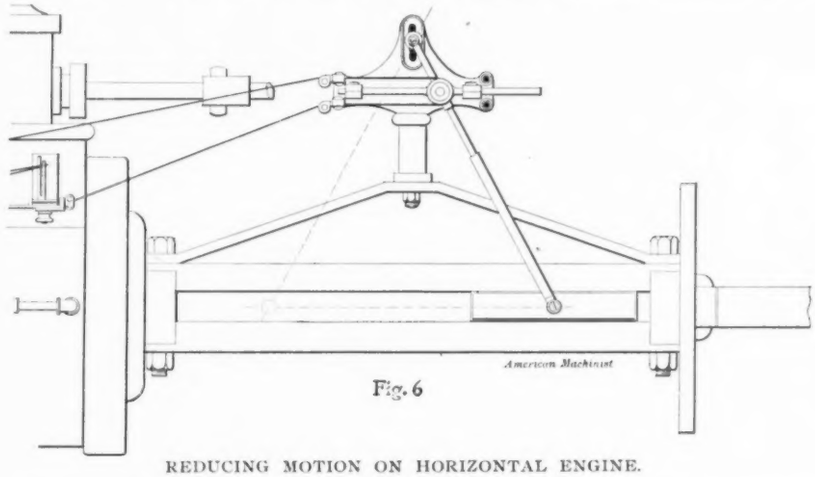
A Reducing Gear for Indicators.

With any engine of respectable size, and in responsible service, and especially with an up-to-date engineer, it is desirable to use the indicator so frequently that a permanently-connected and always-ready reducing motion is a very desirable attachment. The cuts given herewith show two different styles of application of what is apparently a very neat and satisfactory apparatus for the purpose. The details of its construction are also given, so that there is no need of an extended explanation. By means of the slot in the main casting the fulcrum is made adjustable, so that the length of the card produced may be some precise measure, instead of being, as usually, whatever chance may produce. In Fig. 6 the fulcrum is above the sliding rod, and two cards lead off direct to the two ends of the cylinder. In Fig. 7 the fulcrum is below the sliding rod, and one card leads in one direction while a second card leads the opposite way. This arrangement might occur in the case of a steam pump or a steam-driven air compressor. In some cases it is more convenient to use the apparatus horizontally. The vibrating rod, it will be noticed, is telescoped and slides in and out at each stroke of the engine.



DETAILS OF INDICATOR REDUCING MOTION.

This device we understand to be largely an outgrowth of some discussions of indicator reducing motions which appeared in our columns two years ago, although it, of course, is different from anything then shown. It is made by Capt. James Wright, 173 Drolet street, Montreal, Can.



REDUCING MOTION ON HORIZONTAL ENGINE.

Education and Invention.

It is a noteworthy fact that the most important inventions have sprung from the brains of men who have possessed very little precise scientific education, and it is almost equally true that such an education has never done much to develop or aid the development of any invention. It is, of course, an old story that professors never invent anything worth having. It is not quite true. We may, however, leave the professors alone; they have work enough to do without inventing. There are multitudes of well-trained scientists and engineers who are not professors, and we will confine our attention to these, and ask how it is that accurate training seems to rob a man of all power of inventing, and how it is that the best things in the world have been produced by those who have been comparatively ignorant. To explain the phenomenon, we must first settle what invention really is; what the word means; what its use involves. Now, we hold that nearly every invention is, in a sense, a discovery. In courts of law, hundreds of thousands of pounds have been expended in deciding what does and does not constitute an invention, what does and does not constitute a discovery. Let it be conceded, for the sake of argument, for the moment, that the difference between an invention and a discovery is one of degree, and not of essence, and we shall be able at once to understand why a rigid and scientific training may stifle invention. Such a training may be—and in mechanics, at all events, always is—fatal to discovery. It teaches there is nothing left to discover. Everything is known that can be known, for example, about heat and the steam engine, and so on. If a carefully trained student proposes to himself to accomplish a certain thing in a particular way, his training may tell him that the thing he proposes to do cannot possibly be done, because the doing of it would break one of Nature's laws. The result is, of course, that he sits still and does nothing. He bows to the inevitable. Another man possessing far less knowledge does not know enough about the subject to prevent him trying a particular experiment. He tries it and succeeds. Then the learned man finds he knew too much and yet not enough. The invention is a success, and yet its success involves no infraction of Nature's laws. The ignorant man tried the experiment because he was ignorant; the learned man did not, because he held that it would be useless to try it. It cannot be disputed that, under the circumstances, learning did more harm than good.

There are, however, certain inventions which are not discoveries at all; they are inventions by courtesy. They involve little more than the combination in a more or less novel form of old and often well-worn thoughts and things. It does not appear to us that any amount of training could hamper useful progress along this line. On the contrary, it may prove of the utmost service. It may prevent the commission of very serious mistakes, and much waste of time and money; and this brings us back to the starting-point and the proposition that a high scientific training is often and in many ways fatal to the development or exercise of inventive genius. Our readers who have followed us so far will see that the reason why lies in a nutshell; it can be stated in very few words. It is simply that knowledge is too often assumed to have reached finality when it has done nothing of the kind, and the belief is fostered and inculcated by those who write books and treatises and teach, in various ways. We are not now speaking of professors only, but of teachers at large, whether in the college or the workshop. Each man is prone to say: "There, read that or listen to this. There is nothing more to be written or said; I have exhausted the subject, covered the whole ground." A notable example is supplied by a very simple device—the "hurdy-gurdy" or Pelton wheel We have only to take down from our shelves any book on Hydraulics published more than ten years ago, to learn that an impulse wheel driven by the impinging of a jet of water on its vanes must be extravagantly wasteful of water; yet recent investigations have shown not only that the Pelton wheel is very economical, but that it ought to be so in the nature of things. The man of high science produces the turbine, a very admirable invention; but the Californian miner, with practically no training, and plenty of water under pressure, proceeding on quite different lines, turns out a machine very much cheaper and simpler, particularly in the matter of installation, and one not less economical in the use of water.

Lastly, we would point out that it is not the possession of knowledge that stops progress; the mischief is done by the assumption that the knowledge is final. In other words, the training becomes too dogmatical—too monkish, if we may use the word. It cannot, we think, be disputed that most of our leading scientific men know a great deal too much to invent anything; and so the world gets its steam, gas and oil engines, its railways, its high-speed ships, its power looms, its spinning jennies, its horseless carriages, its telegraphs, not from the man of science, not from the teacher, but from the hard worker, who is continually trying new things, because he never learnt that there is a law or limit beyond which he cannot go. No doubt much time and money and labor are wasted; but in the long run, the world owes more to the man who does not believe in the impossible than it does to the man who sees it everywhere.—"The Engineer" (London).

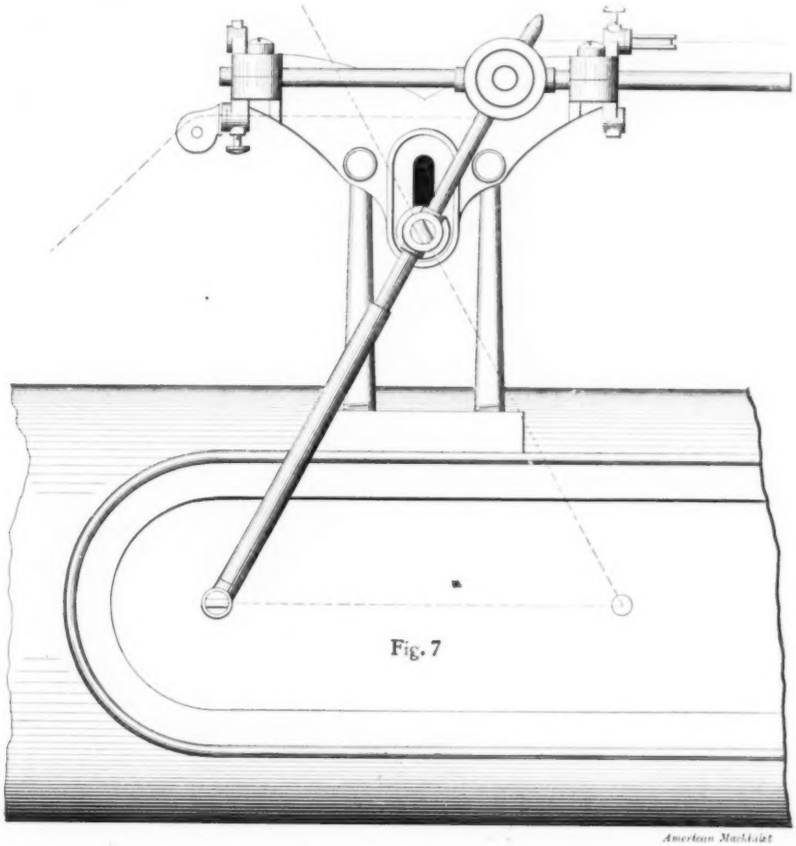


Fig. 7

REDUCING MOTION ON PUMPING ENGINE. (See Preceding Page.)

ELECTRICAL MACHINERY.

Building of a Great Dynamo—VII.

The center magnet piece of the 1,500 horse-power dynamo is a 12-sided polygon, having faces about 31 or 32 inches square, with an elevated partial flange on one side by which the magnet is bolted to the engine frame. The first operation on

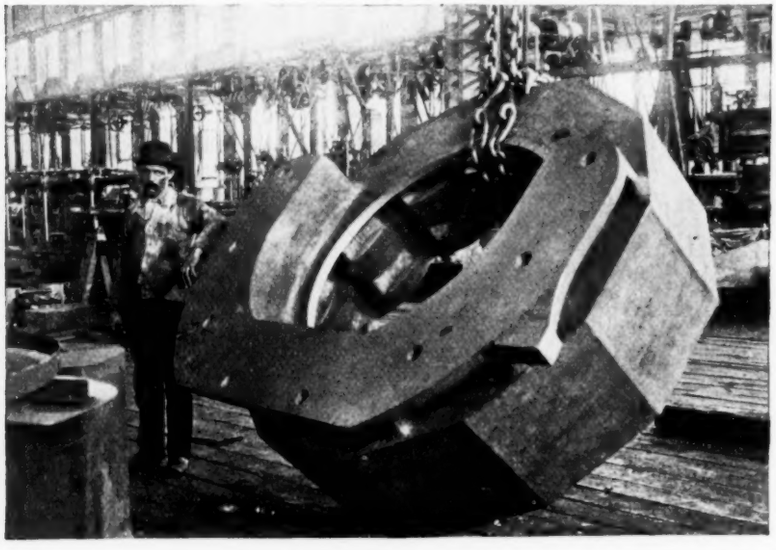


Fig. 27. CENTER MAGNET.

the center magnet, which weighs ten or eleven tons as it comes from the foundry, is to face the flange and opposite side on the boring mill; this facing is simply a good machine cut. The faces of the polygon require as good machine finishing as may be; these faces are the seats to which the steel radial magnets are bolted, each by four large bolts, and the faces on the center magnet piece and on the ends of the radial magnets have to be scraped to a thoroughly good bearing—hence, must be machined as accurately as possible. The finishing of such a large heavy 12-faced mass of gray iron accurately is something of a problem. The center magnet is 10 feet in extreme diameter, too big to go through any planer in the shop; and besides all that, even if a big planer with two tool posts giving 32 inches vertical tool traverse were at hand, it would be very difficult to side down two sides of the polygon at the same time and have them exactly parallel with each other. The problem was solved by the purchase of a "Muskegon Heights" shaper. This shaper, as is well known, does not cut on the out-board stroke of the ram with a pushing cut, in the usual manner of shapers, but on the home travel, with a pulling cut. For this special tool a large finished base, like a planer cross-rail, is provided with a gibbed saddle, and this saddle is provided with a square vertically-acting ram having a tool post at its lower end, and rack and pinion driven for a stroke of about 36 inches.

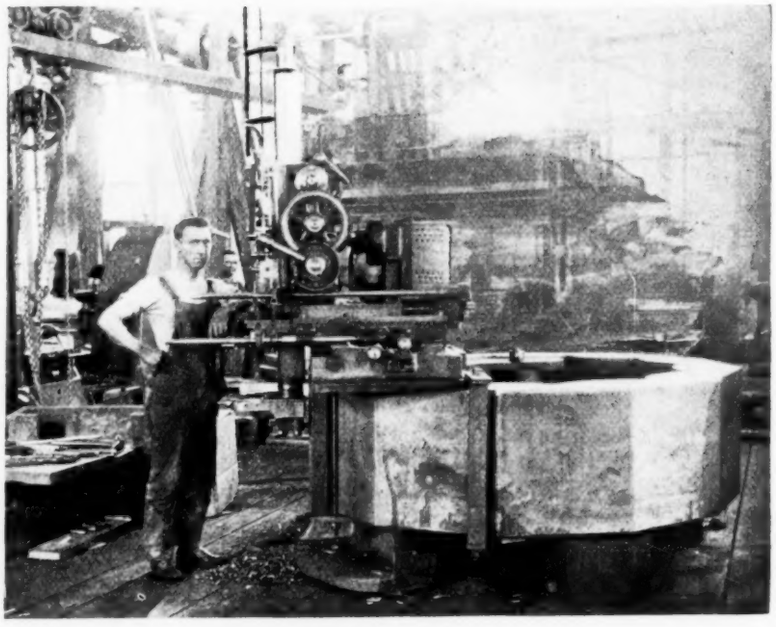


Fig. 28. ELECTRIC-DRIVEN SHAPER ON MAGNET.

First the finish lines of the duodecagon are laid out on the flat side of the center magnet, with the corners in a circumscribing circle marked with a tool in the boring mill; this circle is divided by hand and tram bar into 12 equal parts, and straight lines connecting these 12 division marks define the plane of the faces. The shaper base is then clamped to the flat side of the magnet which stands on its flange on the floor, as in Fig. 28, in line with one of the faces to be finished, and the long-stroke ram is put to work, pulling chips off the magnet face. This peculiar shaper has an electric drive, and so can be moved from one face to another without trouble. The first reduction of speed from the motor is by a worm and worm gear; after that it is all spur gear to the ram. There is no trouble in making the faces smooth and parallel; two cuts are taken over each face, roughing and finishing, and if all goes well, about ten or eleven days' work finishes the faces in good shape. This machine and job show the advantages of the pulling cut in a striking manner, as it may be considered very doubtful if a pushing cut would finish the sides parallel in any case, no matter how carefully it was handled.

After finishing the faces, the next operation is drilling and tapping the 6 stud-holes in each magnet face, 72 holes in all—48 large ones and 24 small ones—as seen in Fig. 29. These holes must all be exactly at right angles to the faces, and must all of them measure just alike from center to center, as they have to match up with corresponding holes in the radial magnets and magnet caps. This is another difficult job, owing to the size and weight of the center magnet; but in this case the difficulties could be met exactly as if the piece were little, and weighed ten pounds instead of ten tons.

When the center magnet, Fig. 27, has its flange faced on the boring machine, it also has an internal spotting ring bored out to gage diameter, as clearly shown in the engraving. The center magnets are different sizes for different sizes of dynamo, but this bored surface is of the same diameter in all, so that all the center magnets can fit one turned male surface the right size to enter the spotting ring. This turned plug to fill the spotting ring is formed on top of a turn-table, and the

turn-table is made to traverse on top of the ways of the special 4-spindle driller shown in Fig. 29. The spindle-head of this driller is also changeable, and different spindle-heads are provided for different sizes of dynamos, so that all the center

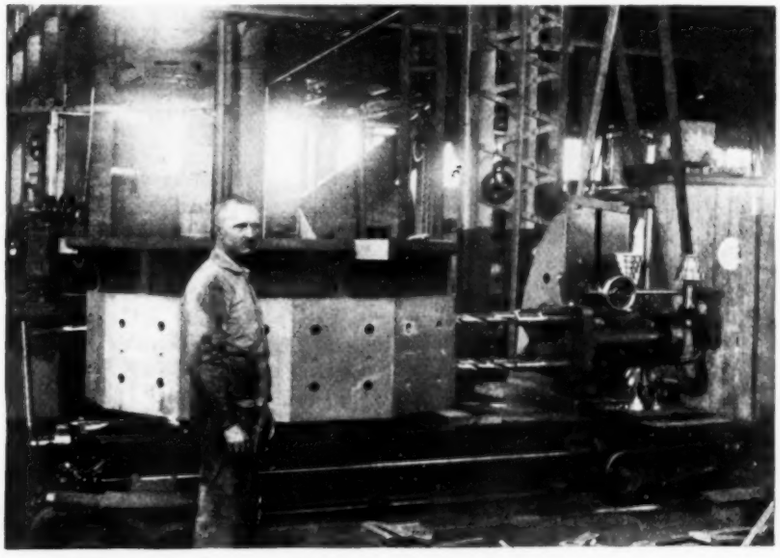
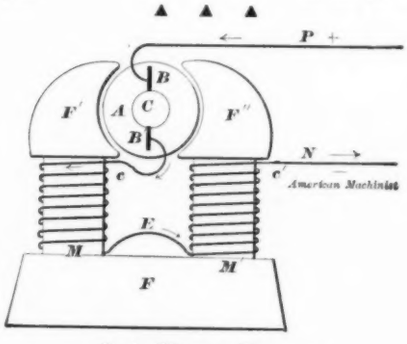


Fig. 29. FOUR-SPINDLE MAGNET DRILLER.

magnets can be drilled on this one machine. The spindle-heads also have a vertical adjustment on an upright at the right-hand end, Fig. 29, and there are 2-spindle heads provided, accurately made so as to locate the pair of small holes exactly in the middle between the large corner holes. With this special machine, drilling out the stud holes in the center magnet becomes a comparatively easy job. H. L. A.



Series Motor or Dynamo

The Action of the Series Motor and Generator.

BY WILLIAM BAXTER, JR.

The engraving shows a series-wound machine, which may be either a motor or a generator—a motor if current is supplied through the wires *P* and *N*, and a generator if the armature *A* is rotated, in which case a current can be taken from *P* and *N*. The series-wound machine is the simplest style of winding, and therefore the best suited to the purpose of explaining the action of such machines.

The machine will first be considered as a motor. In that case the current entering through the wire *P* will pass through the wire on the armature *A*, by way of the commutator *C*. As will be seen, *P* passes directly to the brush *B*. From this brush the current passes into the armature wires, through the segment of the commutator *C*, with which it is in contact. After circulating through all the wire on the armature, it reaches the commutator segment in contact with the brush B^1; it then passes to the terminal *c* of the field magnet coil *M*. After going through this coil it passes by the wire *E* to the second magnet coil M^1, and from the terminal c^1 of this coil to the wire *N*.

The current, in making this excursion through the wire wound on the machine, sets up a condition of things that causes the armature to rotate. The current traversing the coils *M* and M^1 magnetizes the field *F*, the poles F^1 F^2 of which surround the armature. If the current did not pass through the armature—that is, if the wire *P* connected direct with *c*—there would be no tendency to rotate; but as the current does pass through the armature, the rotative tendency is very great. The general way of looking at this action is, that the magnetism of the field pulls the iron core of the armature around; but this is not the correct explanation. The action depends upon the fact that a magnet will push away from its wire in which an electric current is circulating; therefore the force which rotates the armature is the push of the magnetism against the wire on the latter, or, more properly speaking, against the current in the wire.

If we were to connect the magnet coils *M* M^1 with one source of electricity, and the armature wire with another, we would find that if the current through the armature remained constant a variation in the quantity of current through the magnet coils would produce a corresponding variation in the pull or torque of the armature. On the other hand, if we kept the current through the magnet coils constant, and increased or decreased the quantity of current through the wire on the armature, we would also obtain a corresponding increase or decrease in torque. From the foregoing we see that a variation in quantity of current in either the field magnet coils or the armature wire will produce a corresponding variation in the torque. Therefore, if we consider the figure just as it is drawn—that is, with the same current going through both field and armature—we will see that an increase in quantity of current will cause a still greater increase in torque, and a decrease in current a corresponding decrease in torque.

The foregoing facts are so simple as to be self-evident. That a change in quantity of current will cause a change in torque, is not difficult to understand; but there are many who do not see why the current changes, and unless this point is properly understood a clear comprehension of the subject is not possible. Those who have a very limited knowledge of electricity suppose that the only obstacle a current encounters in passing through wire wound upon a motor is the resistance of the wire, and taking this view of the case they cannot see why the strength of the current should change. If the resistance of the wire were the only obstacle to resist the passage of the current, this view would be perfectly correct; but as a matter of fact the resistance of the wire is a very small percentage of the total resistance opposed to the current. The chief obstacle to the flow of current through the armature is the counter-electromotive force which is set up by the action of the motor. The production of this counter-electromotive force has been fully explained in these columns, and need not be repeated here further than to recall the fact that the change in current is proportionally much greater than the change in counter-electromotive force. Since the counter-electromotive force is always nearly equal to the applied electromotive force, leaving but a small difference to overcome the resistance of the wire, it follows at once that a relatively small drop of the counter-electromotive force will double or quadruple the quantity of current. This large variation in the current with a comparatively small variation in the counter-electromotive force causes a great variation in the strength of the field current and magnetism. Since, then, the current through the armature and the strength of the fields are both changed at the same time to a large amount by a small change in the counter-electromotive force, it follows at once that a large variation in torque results.

It has been explained in these columns that with a constant field the variation in speed due to a variation of load is small. In a series motor, however, the field strength is not constant, as the same current flows through both armature and

field. Should an increase of load occur, the first effect is a decrease of speed with a decrease of counter-electromotive force, leading to an increase of current. This increase of current strengthens the field, which, as has been recently explained in these columns, acts to decrease the speed still further. We see, therefore, that with a series motor an increase of load leads to a comparatively large increase of torque, and also to a comparatively large decrease in speed.

With these explanations we can proceed to show the action of a series-wound motor from the instant of starting. We will take a twenty-five horse-power railway motor: Such a machine would have a resistance of about one ohm, and would be operated by a current having an electromotive force of five hundred volts. If we close the circuit, without using any external resistance (to cut down the initial current), the strength of current through both fields and armature at the instant of starting would be five hundred amperes, if the motor were entirely free from inductive action;* but as this condition is impossible, the actual starting current would probably be about three hundred amperes. With this amount of current the starting torque would be very great. This can be realized when we say that a current of three hundred amperes, with an electromotive force of five hundred volts, is equal to about two hundred horse-power. The enormous torque developed at the instant of starting would at once set the armature in motion; but this motion would instantly develop a counter-electromotive force. The passage of the current would then be opposed, not only by the resistance of the wire, but by the counter-electromotive force as well; and as a result, the current would be cut down. This process would continue until a speed was reached where the counter-electromotive force developed would be sufficient to cut the current down to such an extent that the torque of the armature would be just enough to balance the mechanical resistance opposing its rotation. If the motor were running free, the only resistance to motion would be friction; and as this constitutes only a small percentage of the total power of a motor, the velocity would be very great. What the velocity would be under different loads can be shown with a sufficient degree of accuracy, for the purpose of an illustration, without resorting to any complicated calculations. Railway motors generally develop their rated capacity at about 350 revolutions per minute. This velocity for a twenty-five horse-power motor would give a torque at one foot from the center of the shaft of about 375 pounds. This would require a current of about 42 amperes. If the speed is increased until the current is cut down to 21 amperes, the torque will be reduced to something over one-quarter the above amount, in consequence of the current being reduced in both armature and fields. Cutting the armature current in half cuts the torque in half at once, and if the strength of the field magnetism changed in exact proportion to the change in the field current, halving the field current would again cut the torque in half, giving as a result one-quarter of the original torque. In point of fact, however, the field magnetism does not vary in exact proportion with the field strength. With small currents, the magnetic strength of field increases nearly in proportion with the current, but as the current increases the proportionality does not hold good. In dropping from 42 to 21 amperes, the reduction in strength of field would be nearly one-half; but in increasing from 42 to 84 amperes, the increase in field strength would probably be about fifty per cent. A reduction of the current from 42 to 21 amperes would reduce the torque from 375 pounds to about 100 pounds, and the speed would be increased to about 695 revolutions, while the power developed would be about 13¼ horse-power. A further reduction of the current to, say, 10 amperes, would reduce the torque to about 27 pounds, and the speed would be increased to about 1,260, while the power developed would be about 6.5 horse-power. An increase of current to, say, 60 amperes, would increase the torque to about 700 pounds; the speed would be reduced to about 260 revolutions per minute, and the power developed would be about 35 horse-power.

Tabulating these results, we would get the following:

Amperes.	Torque.	Speed.	Power.
60	700 lbs.	250	35 H. P.
42	375 "	350	25 "
21	100 "	695	13¼ "
10	27 "	1,260	6½ "

These figures show that a small change in speed produces a great change in torque. On this account this type of winding is well adapted to railway work, and that is the reason why it is there used.

For driving general machinery the series-wound motor is not suitable, because, as the above figures show, it will not run at a constant speed with variations in load. The reason for this is as follows: When the mechanical resistance that opposes the torque is reduced, the first effect is to increase the speed. This increase of speed increases the counter-electromotive force and reduces the current. The reduced current in turn reduces the field strength of a series motor, and, as was shown at length in a recent article in these columns, entitled "Electromotive Force, Counter-Electromotive Force and Speed," reduction of field strength involves a further increase in speed.

Now, it is evident that if we can so wind a motor as to keep the strength of current passing through the field coils constant, we will greatly reduce the variation in speed required to increase the counter-electromotive force enough to obtain the necessary decrease in torque. If, in addition to this, we can so wind the armature that a very small change in the counter-electromotive force will produce a great change in the current, we will have a motor that will run under wide variations in load with a small change in speed. These results can be accomplished by what is known as "shunt-winding." The shunt-wound motor will be discussed in a future article.

The action of the series machine as a dynamo is more easily explained.

There is no difference between a motor and a generator. If we pass a current through the machine it is a motor, and its power may be utilized by placing a belt on the pulley. If by the same belt the machine is driven it becomes a generator, and an electric current may be taken from the ends of the wires. If the machine is efficient as a motor it will be efficient as a generator. As a motor the rotation will be in the opposite direction if the wire connections are not disturbed. If it is desired that the machine should turn in the same direction, the commutator brush connections should be reversed.

A series-wound machine, as shown in the illustration, will deliver a constant current at constant electromotive force, if it is driven at a constant speed and the resistance in the circuit is kept constant. If the speed is increased the electromotive force is increased, and with it, of course, the current. Dynamos are naturally run at a constant speed, and the action under a change of resistance is of more interest. If the resistance is decreased, the immediate effect is an increase of current. With the series connection of the field, this increase of current strengthens the field, and the increased strength of field increases the electromotive force, leading to a still greater increase of current.

This machine, therefore, is not self-regulating as a generator, any more than it is as a motor. Generators of this type are used for "arc" light dynamos; but in order that they may give satisfactory results, a regulating device of one kind or another is used.

Arc lamps are usually arranged in series. The quantity of current must be kept constant regardless of the number of lamps burning; but the electromotive force must increase as the number of lamps is increased, in order to force the required quantity of current through the increased resistance.

No method of winding a machine so that it will deliver a constant current with variable electromotive force, has been devised that will give satisfactory results in practice; therefore all the machines of this class are provided with other means for effecting the regulation.

*The induction is a sort of back pressure set up by a sudden rush or increase in current. An explanation of the subject is not believed to be advisable in this article, as it would only serve to complicate the subject under consideration.

Letters from Practical Men.

That Compressed-Air Paradox.

Editor American Machinist:

In the issue of the "American Machinist" of April 16th, the article by Frank Richards, entitled "A Compressed-Air Paradox," has puzzled me somewhat. I suppose it would be more correct to say it has puzzled me to see how he arrived at the conclusions he did. I have done no figuring, because I suppose the figuring is correct. I must say, however, that the reasoning appears to me incorrect. It seems to me a case of incorrectly applying a correct formula, or of making a general application of a limited formula. The paradox seems to me more fancied than real.

Let us do a little common-sense reasoning on the matter and let formulas alone. Let us take the first instance cited, that of a terminal pressure of 15 pounds gage and 5,000 feet of 3-inch pipe. Mr. Richards figures on initial pressure of 191.7 pounds as necessary in this case. Now, with a terminal pressure of 45 pounds, he figures an initial pressure of 89 pounds only will be necessary. The reason given for this I can clearly understand, namely, that the air being more compressed, and occupying less volume, will move through the pipe at slower speed, and thus have less friction to overcome. I cannot agree with his result, however. I think the first case will need the lowest initial pressure.

With the terminal pressure 15 pounds there will be considerable velocity to the air and corresponding friction to overcome. There will be a point more or less removed from the outlet where the pressure will probably be 45 pounds. This point will probably be some distance from the exit. Thirty pounds pressure will overcome considerable friction. Why, in effect, may not this point be considered as the outlet of a new pipe line having a terminal pressure of 45 pounds and an initial pressure to correspond? As this pipe is less than 5,000 feet long, and has the same terminal pressure as that assumed for the second case, the friction must be less and the initial pressure less. How the pressure can increase faster in one pipe than in another, beyond the points of equal pressure, I cannot see. The friction losses in a portion of the pipe must be less than in the whole.

The initial pressure therefore, instead of being 191.7 pounds, will be less than 89 pounds, granting that 89 pounds is correct under the conditions for which it was given. The same reasoning will apply to the other example cited. I cannot see how a lower initial pressure will be necessary where the terminal pressure is 60 pounds, than where the 60-pound point is removed some distance back from the exit. The formula, as applied to these two cases, seems to be applied to conditions widely outside the limits for which it was intended.

The formula used makes the volume an essential function. The really essential function is the velocity, volume being functional only indirectly. The velocity, however, decreases as the pressure increases, while the formula evidently supposes the velocity to be the same at all points. I would ask here can a formula for this purpose, correctly applicable to all conditions, be constructed without recourse to the calculus? Approximate formulas, or those having a limited application, are all right if their limitations are understood. Where their results are clearly contrary to common sense they should not be used.

H. L. REYNOLDS.

▲ ▲ ▲

Editor American Machinist:

In the current issue of the "American Machinist" there appears an article by Mr. Frank Richards, entitled "A Compressed-Air Paradox." He calculates that, to transmit 2,000,000 cubic feet of natural gas in 24 hours through a pipe 6 inches in diameter, 12 miles long, with a terminal pressure of 1 pound, the gas must be compressed to a pressure of 1,379 pounds per square inch; and with a terminal pressure of 60 pounds instead of 1 pound, it is only required to compress the gas to a pressure of 122.79 pounds From these figures it is evident that it is more economical to transmit compressible fluids at high pressures, allowing the energy stored in the fluid at the delivery end to escape as lost energy, than it is to transmit at a lower pressure and have no surplus energy stored in the fluid at the terminal.

I would like to ask Mr. Richards if this is what he calls a paradox. I think that if his formula for the loss in head would take into consideration that the velocity varies inversely as the pressure, his initial pressure for the lower terminal pressure would be very much reduced.

On page 489 of Kent's "Mechanical Engineer's Pocketbook" appears a table, by Mr. Richards, of the head or additional pressure in pounds per square inch required to deliver air at 75 pounds gage pressure through pipes of various sizes and lengths. In this table is stated that 1,500 cubic feet of free air per minute are transmitted through a 6-inch pipe 5,000 feet in length, with a loss of 3.99 pounds pressure. This means that the initial pressure necessary to transmit this volume through the given length would be 94 pounds absolute, the terminal pressure being 75 pounds by gage. Now, if the volume delivered be increased to 3,000 cubic feet per minute, the additional pressure required would be 16 pounds. In delivering this volume at one-half the above terminal pressure, or 45 pounds absolute, we would require an initial pressure of 61 pounds. If we again increase this volume to 6,000 cubic feet per minute, delivering it at one-quarter the above terminal pressure, or 22½ pounds absolute, the additional pressure required would be 64 pounds per square inch, making initial 86½ pounds. If we again increase this volume to 12,000 cubic feet per minute, reducing the terminal pressure to one-eighth of the above, or 11.25 pounds, the additional pressure required would be 256 pounds per square inch, making an initial of 267.25. Thus, it will be seen that with 1,500 cubic feet of free air delivered at an absolute pressure of 90 pounds per square inch, the initial pressure required was 94 pounds. With 12,000 cubic feet of free air delivered per minute, the terminal pressure being 11.25 pounds absolute, the initial pressure was 267. The amount of energy stored in the air at the delivery end is the same in the two cases; but the amount of energy required to compress it at the initial is approximately twenty-four times in the last case that required in the first. Therefore, it is evident that, as stated above, it is more economical to transmit compressible fluids at high terminal pressures, allowing the energy stored in the fluid to escape as lost energy, than to transmit at lower pressures.

I would like to ask Mr. Richards whether I am correct in this deduction.

W. COOPER.

Schenectady, N. Y.

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Greek Letters in English Formulae.

Editor American Machinist:

I was glad to read your pertinent editorial of March 26th, on the "Treatise as a Book of Reference," since I have been thinking of troubles of my own in the same line during the last three months. It seems to me it is time that writers on pure and applied mathematics and kindred subjects took the trouble to adopt a more consistent, uniform and consequently useful code of letters and signs in algebraic formulæ and geometric diagrams accompanying them.

What business has a character that is strange to our eyes, foreign to our language and unlike the thing it represents, in a workman's formula? Why are there so many Greek letters—crumbling bones of a two-thousand-year dead language—cropping out in text and reference books for English-using readers? Why load down practical formulæ with so much foreign, forget-able material that is doubly "Greek" to the still greater number of men who would find the formulæ useful if they understood them?

I expect to hear in answer that the Greek letter serves to keep an important thing or idea separate from the common things or ideas considered at the same time—a more convenient handle by which to work the thing. The trouble is, that after we are out of school—and very often while we are in school—we forget the name of the handle and it no longer fits our hand, as it were, and we are continually in the awkward predicament of hav-

ing to find or make a handle for a handle before we can handle it!

In the one case, above all others, where an outsider would suppose a foreign character would be useful and appropriate to represent an idea of frequent occurrence and radical difference from the rest of the formula one of the commonest of common letters is found carrying on the important work—that is the *d*, for the sign of differentiation in calculus. The sign of integration, is, however, very appropriately represented by $\int$, which will pass for *s*, the initial of "sum," and yet will not be mistaken for it. Some authors seem to regard its use as a mistake, however, since they strive to put some Grecian, angular grace into the sign by bending it into this shape Σ and calling it Sigma, which may possibly mean "sum" or be its first letter in Greek.

Unwin's "Machine Design" bristles with Greek, and is well supplied with inconsistencies of uses of letters: For instance, *H P* and *H. P.* mean number of horses' power, while *P N* means *P* multiplied by *N*. In speaking of riveted joints, *d t* means diameter of rivet times thickness of plate, but in other places it means "differential tee."

As a starter toward better order in formulæ, I would offer the following suggestions, hoping to hear from others in criticism, improvement and additions:

First and foremost—Let only well-known or easily recognized characters be used—for letters, English; for numbers, the common figures, not I, II; for operations, the common mathematical signs; and for angle, etc., signs which imitate the thing—as $\llcorner$ for angle, $\perp$ for perpendicular, etc.

Second—Let all points, and bodies referred to as a whole, be indicated by capital letters only—as shaft *A*, "line *B C*" (meaning the line passing through, or whose ends are the points *B* and *C*).

Third—Let small letters be used to represent quantities always; never to represent points.

Fourth—To show that points or quantities are similar, use the same letter with different subscript figures, or smaller letters—as B_t, B_f, B_s for top, front and side views of point *B*; or s_c, s_t, s_s for crushing, tensile and shearing strength *s*.

Fifth—Ideas like differential, integral and the like, which are radically different in meaning from the ideas ordinarily found in formulæ, but which are still used frequently, should be represented by characters equally different to avoid confusion.

Of course, while criticising the shortcomings of manuals, we should remember that we owe their authors many thanks for substantial assistance over roads that would be without a guide to us but for them; but, on the other hand, there are text-books by the dozen on subjects so old that the plea of pioneering will not excuse the author for getting so far away from practical roads.

JOHN C. BLEY,
Armour Institute Technology.
Chicago, Ill.

[The difficulty of learning the notation used in any book is about the smallest incurred in reading the book, and we do not think the plan suggested by our correspondent would go very far toward lightening the task of reading any mathematical treatise. Moreover, the difficulties in the way of getting any such plan universally adopted are practically insuperable, and certainly not worth the effort for the benefits to be realized. Meanwhile, what would our correspondent do with existing books? The learning of the few Greek letters commonly used is a trifle for each student, and it is certainly far more practicable for each one to do this than to endeavor to have it done for him by striving for concerted action among writers in abolishing them.

What can be more natural than the use of *H P* for horse-power, and what can our correspondent suggest that is better for the purpose?

So far as the suggestion of using characters outside the alphabets for ideas different from those ordinarily found in formulæ is concerned, the difficulty of finding type for them crops up at once. A portion of our correspondent's letter cannot be represented for this reason.

Our correspondent is in error in saying that the signs $\int$ and Σ are synonymous. The latter is the sign of summation of a limited number of actual values, each being known. As related to $\int$, it is a sign of an approximate result, while $\int$ is an accurate one. The sign Σ is justified by a real need.—ED.]

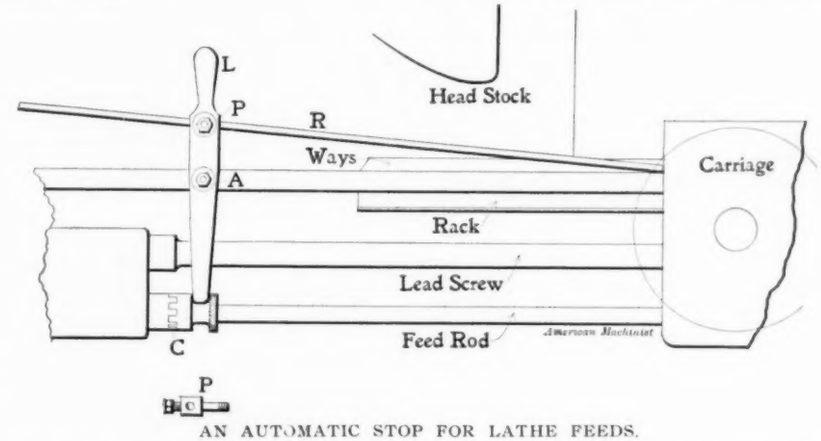
An Automatic Stop for Lathe Feeds.

Editor American Machinist:

I inclose you a sketch of an automatic stop which may very easily be put on a Flather lathe. I put one on a 26-inch lathe in about 2½ hours.

A hole was tapped into the frame at *A*, into which a cap screw was screwed to hold the lever *L* in place. At *P*, a pin with a hole through the head was inserted. Through this hole, in the head of the pin *P*, a rod *R* passes and is clamped in the desired position by a set screw behind the lever. When the carriage strikes the end of the rod *R*, lying in the ways, it throws over the lever and releases the clutch *C* and stops the feed. The same thing could easily be arranged to work with carriage feeding toward the tail-stock.

F. S. HARTWELL.
University of Wisconsin.

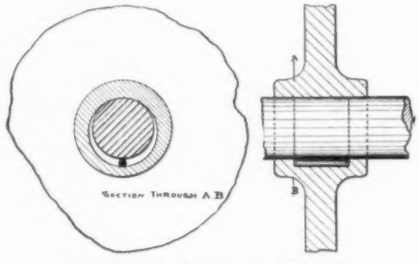


AN AUTOMATIC STOP FOR LATHE FEEDS.

A Self-Tightening Pulley.

Editor American Machinist:

I had occasion recently to take apart a machine imported from Germany, and found that the pulley had a method for fastening on the shaft which was new to me at least, and I send you a rough sketch



A SELF-TIGHTENING PULLEY.

of the same, hoping it may interest some of the readers of the "American Machinist." There has been some discussion lately in your columns in regard to methods of fastening pulleys on shafts, and this sketch may be apropos, although the pulley to which it was applied was a small one, about 8 inches in diameter. I made a number of pulleys for the owner of the machine; and although I informed him that he had better have them fastened with set screws, he insisted on my making them in all respects like the sample, and explained his reason was that, by turning the pulley backward until the round roll reached the widest part of the eccentric chamber, he could easily slip the pulley off the end of the shaft for the purpose of cleaning the same.

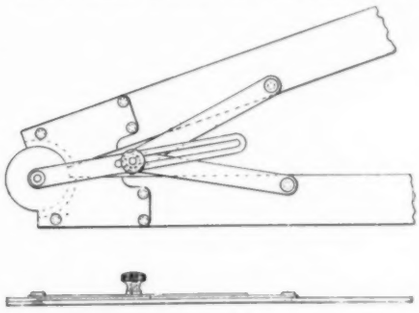
J. P. WILLIAMS.

An Adjustable Angle for Draftsmen.

Editor American Machinist:

The discussion opened in your columns by Mr. Swift on a "Third Triangle for Draftsmen" has been deeply interesting to me; and when another correspondent gave new life to the subject by starting it in another direction, that of the adjustable angle, I determined to send in my little piece on that very convenient tool.

I inclose you sketch of the one I have made, which I find very convenient. It



AN ADJUSTABLE ANGLE FOR DRAFTSMEN.

is adjustable from 0° to 90°, and the clamping device being very positive, it is not liable to be disarranged in using, this, I think, is the defect in those which have been shown. The blades are of celluloid, which is the only best material to use for draftsmen's angles. The only thing my angle needs to make it perfect is a protractor attachment, so that the desired angle can be set on it at once. Perhaps some of the readers of the "American Machinist" can suggest a practical scheme for the purpose, and do the drafting profession a favor.

T. H. FAIRWEATHER.

Brooklyn, N. Y.

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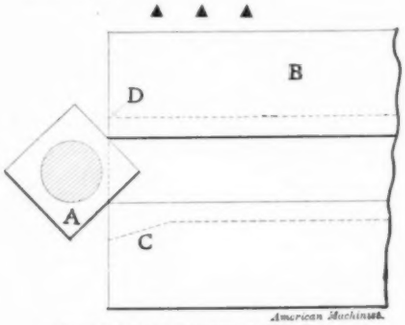


A MILLING-MACHINE DIFFICULTY.

"A Milling-Machine Difficulty."

Editor American Machinist:

If "Theo," in your issue of April 30th, will cut out the T-slot in his platen, as marked at *C* on dotted lines, he will not hear any more cuss-words. The idea is that, when the bolt-head strikes on the corner marked *D*, the bolt will turn around so that the corner *A* will pass by the corner *C*, where the stock has been taken off. I hope this is plain enough.

J. MOFFIT.

Providence, R. I.

A Neat Differential Pump.

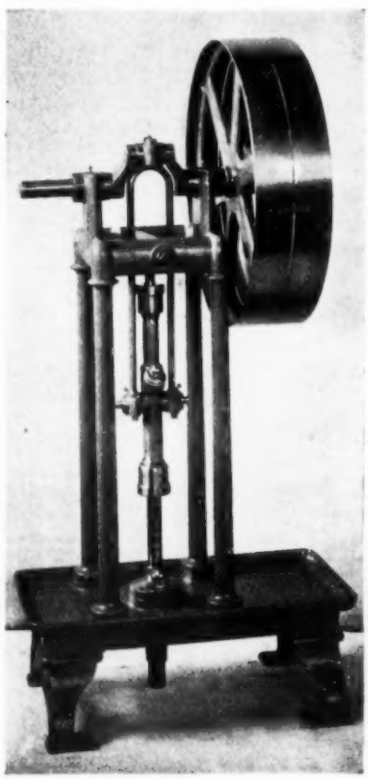
Editor American Machinist:

As you have recently published a few novel pumps, I send you a photo of one of my own "freak designs," used as a pressure pump to test small globe valves. It contains but two valves, as you can see in the photo, yet is double-acting, discharging each stroke, but the suction not acting on the downward stroke—a so-called "differential."

If you care to publish it, you may do so. Though built in the latter part of the '80's, it has never been published, to my knowledge.

CHAS. E. CHURCH.

Norwalk, Conn.



A DIFFERENTIAL PUMP.

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The Elliptical Chain Wheel.

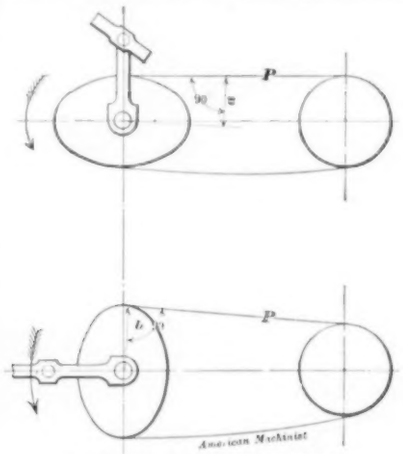
Editor American Machinist:

Seeing in your paper, page 108, the description of the "lever" chain for bicycles, reminded me of a question which has several times occurred to me, being in reference to the elliptical sprocket wheel which was quite popular on bicycles a couple of years ago, though now it is not furnished by any maker, so far as I know. As you probably know, this was intended to render the turning moment on the driving wheel more uniform, and to counteract to some extent the results of the different crank positions.

Are not the moments measured as indicated in sketch, *a* and *b* being the respective lever arms acted on by the pull *P* in the chain?

The question is, then—Is it the tooth on the large sprocket wheel at the point of tangency of the chain that does the driving, or is it the pull distributed between all the teeth in the arc of contact of the chain and wheel? If so the proportion borne by each must vary according to its distance from the center of crank axle. It is necessary, of course, in this case that there be no difference in pitch between chain and wheel.

I never had an opportunity to test the elliptical sprocket wheel myself, and I do not know whether the advantages claimed



ELLIPTICAL CHAIN WHEEL.

for it were realized in practice. It may be, however, that the manufacturers never made the eccentricity of the ellipse enough to make a difference of any consequence, and this may be one reason why it "went out of fashion." K.

[The effect of the elliptical driving wheel is, of course, to make the treadle movement somewhat slower at the middle of the descent and somewhat quicker when passing the centers. The chain would be slack when the wheel was in the first position, if tight when in the second position. If geared two to one, the slackness could be corrected by an eccentricity of the small chain wheel. The pull of the chain would always be tangent to the ellipse, and the radius at the point of tangency would determine the leverage. All the teeth with which the chain might at any time be in contact might help to hold the chain from slipping, but they need not be taken into account in computing the power distribution. It would seem that the elliptical sprocket wheel would be more effective, and, for a time perhaps, more valuable as a selling device than for a driving gear.—Ed.]

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Changes in Iron in Contact with a Chill.

Editor American Machinist:

In reading Mr. L. C. Jewett's answer to "A. R. J.," I was somewhat surprised, and would like to ask Mr. Jewett, through your valuable paper, a question or two in regard to his statements.

He says that the graphite is changed into combined carbon by coming into

contact with the chill or iron part of the mold. If such is the fact, why not make the castings to be chilled from No. 1 charcoal iron, as that certainly contains more graphite than a No. 3 iron, and certainly more than No. 4 or No. 6?

Again, what is the use of making these higher numbers of iron, which contain less graphite and more combined carbon, if his theory is correct?

Now, I would like to ask Mr. Jewett if he can chill No. 1 charcoal iron if his chill is three feet thick. My experience, after twenty active years in the chilled-iron business, is that it can't be done. All he can do is to close the grain and darken the iron that comes in contact with the chill. Now, I have been making and mixing the iron for crusher jaws for the past ten years, and never make the chill thicker than the casting, so that the chill that "A. R. J." uses is plenty thick enough, for I can chill them clean through without any difficulty; but perhaps this is owing to our great altitude—who knows?

E. GRINDROD.

Helena, Mont.

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Editor American Machinist:

Answering the letter of E. Grindrod, Helena, Mont., criticising my advice to "A. R. J." as to thickness of chill, or thicker chill than the dimensions given by "A. R. J." in his inquiry, I will state in this connection that I have never been shop-mate with crusher work, but have had considerable experience with other chilled work, such as car wheels, rolls and stamps for stamp mills, glass molds, etc., where the depth of chill was an important factor in the castings required.

The point I tried to make clear to "A. R. J." was, that the rapid or sudden cooling of the liquid iron had an important influence on the depth of chilled portion of a casting, and that a thick chill would take care of the heat and extract it quicker from the liquid iron during solidification than a thin chill would. When the thickness of chill was mentioned, extremes were not intended; neither was it to be inferred that, if thick enough, any mixture or grade of iron could be chilled.

My friend in Helena asks if I can chill No. 1 charcoal iron if chill is three feet thick. No; I don't claim that, as No. 1 charcoal iron is that rich in graphitic carbon that all the graphite would not get changed into combined carbon during solidification, and that must occur to produce a white crystalline chill. Just what the result might be if repeatedly melted and poured on a chill, I would be much interested to see tried. I think, however, if that portion of a casting of No. 1 charcoal iron—that portion in which our friend says the grain is closed and made darker by contact with the cold chill surface—was analyzed, it would show a greater percentage of combined carbon than parts of same casting farther removed from the chill, be the latter 3 feet or 1 inch thick.

I have had some experience with glass iron molds with chilled surfaces to be dense and close-grained; the surfaces in contact with chills 1 inch or 1¼ inches thick were very perceptibly harder, and density deeper, than if chills ¼ inch were used. Thick chills will keep their shape longer without warping than thin chills, as the repeated uneven expansion frequently causes flat chills to warp if thin.

If I may be allowed, I would refer my Montana friend to the very interesting and valuable work, and an acknowledged authority on Metallurgy, entitled "A Manual of Metallurgy," by William Henry Greenwood, F. C. S., Associate of the Royal School of Mines; published by G. P. Putnam's Sons, New York. On page 51, Article 58, it reads: "In cast or pig iron the carbon exists in all cases both as combined and graphite carbon. In gray iron wholly as graphite. But in white iron, i. e., chilled of 'Speigeleisen,' the carbon is almost wholly combined, only a small quantity existing as graphite. Cast iron in its fluid state holds an amount of carbon in solution which, as the metal cools slowly, separates as graphite; while if the metal be suddenly cooled, the greater portion of the carbon is retained in combination with the iron." Chapter VI, page 61: "Gray pig iron, if suddenly cooled, becomes white Swedish pigs, which are cast as rectangular plates in iron molds, thus chilling the surface. It is found that however gray the bulk of the metal may be, it usually exhibits on fracture a skin of white, showing the chilling effects of the iron mold on the liquid metal, attended with the conversion of the carbon at the chilled surfaces wholly into combined carbon." Similar testimony on pages 117 and 118.

Also refer our friend to the "Encyclopedia Britannica," where, by the opinions of such eminent metallurgists and chemists as Kartsden, Gurlt, Mattieu and Williams, etc., he will see that the complete combination of the carbon with the iron is absolutely necessary to obtain a good chill: "The hotter the iron the more thoroughly is the graphite in solution with it, and the quicker the solidification the deeper the chill, from the greater quantity of graphite changed to combined carbon," etc., etc.

It seems from all this testimony that there can be but one conclusion, as named in my advice to "A. R. J.," "to make the iron as hot as possible and pour it hot, and cool it quick; and if a comparatively thin chill won't or does not do it, to make chill thicker is a good and inexpensive thing to try. It would last longer, cost no more to make or handle, and the extra metal in it would be there when it became scrap." Altitude I don't think has anything perceptibly to do as to chilling iron; at least, I do not know that it does. But I do know that the working of the cupola, mixture of the iron, temperature it is poured, and the thickness of chill to insure rapid solidification, one and all, are conditions not to be ignored in successful manipulation of chilling irons and the product thereof.

L. C. JEWETT.

Boston.

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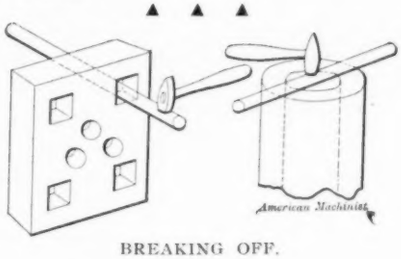

BREAKING OFF.

Breaking Off a Piece.

Editor American Machinist:

In your issues of March 5th and May 7th the items of Tecumseh Swift and "Spiral" interested me very much. But why not do away with the manner of breaking off a piece as done by both Mr. Swift and "Spiral," and try the following plan? With either tool steel, Burden's best, or Norway iron, I have found it works equally well:

Nick bar slightly on both sides, and pass through hole in swage block so that nick on bottom shall come even over edge of block, with back end of bar raised against upper side of hole. A blow on end will break it off very easily and squarely. If a long bar, place over any heavy piece that has hole through it of four or five inches in diameter. Place nick over center of hole and strike squarely over nick, as per sketch.

SHORTY.

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Admission Requirements to Engineering Schools.

Editor American Machinist:

The interesting discussion carried on in your columns on this subject, together with the question put by Mr. William O. Webber in his communication of March 12th, "Where can we find the ideal engineering school on these lines, turning out good foremen, superintendents and chief engineers as well as professional men?" leads me to suggest that the table furnished herewith gives, in some measure, an answer as to what the graduates of the Worcester Polytechnic are doing. The table gives a résumé of the entire graduate body for the years 1871 to 1895, inclusive, embracing a total of 650 men in fourteen classified occupations, the figures in the body of the table giving the percentage (based on the total membership of each class) of its members in each occupation. The number of men on which the percentages in each case are based, is found at the foot of the column bearing the year of the class graduation.

Of the 650 men recorded, but 4 per cent., or 26 men, are not engaged actively in lines of work for which the Institute course specially prepared them. Of the

remaining 164 men in unclassified occupations, marked "Others," it may be said that the catalog of the Institute does not give with sufficient clearness the occupations of these, though they may in general be classified with the others, and this classification is in no way an indication that they are not in active service in some of the lines that are mentioned. A reference to the table will show at a glance that the largest proportion of the men get into business for themselves. This is especially true of the older classes. The next grade may be named as the "Managers in Business," and in this grade, as well, the older classes are largely represented. "Superintendents," "Mechanical Engineers" and "Assistant Engineers" are also well filled out with older classmen. The positions of "Draftsmen," "Professors and Instructors," "Chemists," "Electricians" and others are more fully occupied by the more recent graduates; and also, the proportion of the unclassified is far greater in the recently graduated classes. The logic of the table would therefore seem to be that the more responsible positions are gained after years of service, to which the Institute training is merely the foundation, and in no way a part of the superstructure. At this juncture it is pertinent to point out, therefore, that no Institution, however thorough or severe its course of instruction and training, can be supposed to turn out anything—foremen, superintendents, or anything else. It simply turns loose a lot of raw material, from which, later on, these various grades of engineers may develop.

The one element which must be forever lacking in the training of engineering schools is that of competition, which is the life of the business world; and you may no more expect to produce successful men in any of the occupations named, without this element, than to read English without a knowledge of the alphabet.

The number of men applying for admission to the best grades of our engineering schools is far in excess of their facilities to accommodate them, which is in itself the best proof of the value of the training they are giving, and furnishes a school with its best means of keeping to the high standard of the past, and enables it to produce a better standard for future classes by selection of a portion only from the large number that apply for admission to its courses of instruction. The raw material thus operated upon by the schools is constantly, by virtue of the severity of the prescribed requirements for entrance, more thoroughly equipped and of a better sort than formerly, and we may reasonably expect better things of the coming years' products from these schools than the past, as shown—good as it has been. The writer believes, therefore, that the requirements of admission to our engineering schools may by no means be lowered if we propose to have the future engineer an improvement along all lines. This position by no means controverts the fact that more trade schools and more manual training schools and institutions, easier of access and having less admission requirements, are needed; in fact, these schools are the very best allies that the true engineering schools can possibly have.

MARK TALCOTT.

OCCUPATION.	YEAR OF GRADUATION.																									Total for Each Grade.
	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	
Partner in business	37	50	16	23	62	35	23	29	35	7	29	32	28	17	16	31	23	21	9	6	9	..	..	2	2	119
Manager in business	..	..	16	7	6	10	5	17	10	14	6	11	..	13	15	7	6	..	..	6	6	3	6	..	..	37
Superintendent	6	..	8	8	6	..	..	5	..	7	23	11	6	13	10	10	..	3	6	..	..	3	2	3	2	32
Mechanical Engineers	6	..	12	..	..	6	5	..	5	..	..	..	11	..	4	3	7	..	..	12	3	3	6	2	..	22
Assistant C. E. and M. E	12	6	6	8	..	23	24	6	10	21	12	3	..	8	4	7	10	9	..	12	6	9	2	9	..	48
Assistant Superintendent	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	..	3	2	3	2	6
Draftsmen	..	..	6	..	..	6	5	12	5	..	6	11	17	8	..	3	..	12	16	12	9	21	12	13	28	61
Professors and Instructors	6	12	6	15	..	12	5	..	10	7	..	6	11	4	8	17	23	18	12	12	10	3	7	13	3	91
Chief Engineer	..	..	..	..	..	..	..	..	..	..	..	7	..	4	..	..	..	3	..	..	..	..	..	..	..	4
Master Mechanic	6	6	..	..	..	..	..	..	..	..	..	..	..	4	..	..	..	3	..	..	..	..	..	..	..	4
Chemists	..	..	..	..	..	..	..	6	..	..	6	..	..	..	..	..	3	9	..	9	6	6	8	..	7	20
Electricians	..	..	..	..	..	..	..	..	..	7	..	4	..	..	..	..	..	..	18	6	3	3	5	3	..	17
Examiner, U. S. Patent Office	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	..	6	..	3	12	6	..	..	13
Assistant Manager	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	2	..	..	2
Others	21	26	30	39	26	8	28	25	25	37	18	18	27	9	17	22	18	22	27	21	42	32	42	52	56	190
Total in each class	16	16	16	13	16	17	21	17	20	14	17	28	18	24	25	29	30	33	33	33	31	32	49	47	47	659

NOTE—The figures in the body of the table give the *percentage* based on the number in each class of its members in each occupation.

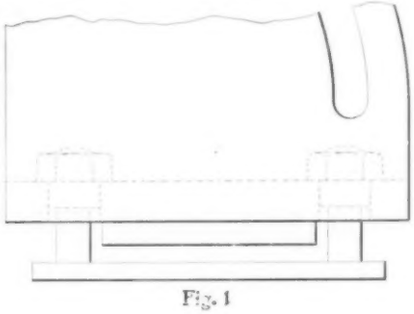

Fig. 1

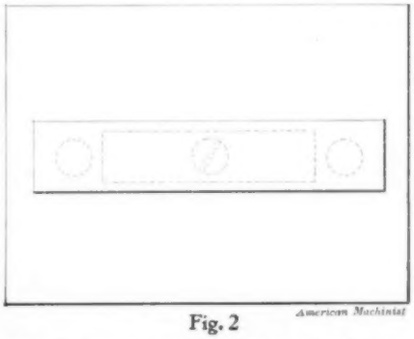

Fig. 2

BOLTS FOR DIVIDING HEAD OF MILLING MACHINE.

Bolts for Dividing Head of Milling Machine.

Editor American Machinist:

"Theo's" reference to difficulty with dividing head bolts (April 30th issue) has touched me on a tender spot, as I have not only experienced the "bruised fingers and ——," but on several occasions have very nearly dropped this expensive piece of mechanism on the floor when attempting to place it on the platen.

The remedy that had occurred to me was to make one long head common to both bolts, as shown in elevation in Fig. 1 herewith, and bottom plan in Fig. 2. I think the way I show would be more effective than "Theo's" after the thing was made, as in his device the resistance to turning is quite near the center of the bolt, but in mine it is as far off as the distance between the bolts. On the other hand, my two bolts with one head would be an awkward piece to machine, while "Theo's" method is not only easy of execution, but is readily applicable to the machines as they already exist.

Another thing that has occurred to me, was that two counterbored holes could be made in this long bolt-head, that were a loose fit on two shouldered screws tapped into the bottom of the tongue; so that when some other chump loosens the two large holding nuts more than is necessary in taking the head off the platen, the long bolt-head will not drop down far enough to strike the bottom of T-slot when I want to put it back.

WALTER GRIBBEN.

Brooklyn, N. Y.

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American Windmills in Nicaragua.

United States Consul Lewis Baker, Managua, Nicaragua, reports that H. E. Low, at present acting as American Vice-Consul at that port, struck the idea that he could run certain machinery on his farm in the mountains by wind power. He ordered a windmill from Chicago, and attached to it his hulling and other machinery necessary for cleaning coffee. When all connections had been properly made, the result was far beyond his most sanguine expectations.

This successful termination to his experiment will doubtless lead to a large number of orders in the near future for American windmills.

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The "Wood Worker" says that "each year it becomes harder for incompetent men to succeed in any wood-working business." If it were otherwise, the wood-working business would be a very peculiar one.

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▲ ▲ ▲

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Damage to Machinery by Fire.

The subject of the damage to machinery by fire was brought up at the St. Louis meeting of the A. S. M. E., and was discussed somewhat, but, it seems to us, inadequately, all the expressed opinions being in effect that machinery is utterly ruined by going through a fire, and that an insurance company should pay for burned machinery the full difference between its value previous to the fire and its value as old iron.

With all due respect, we must differ from this opinion, as we think very much depends upon what kind of machinery is burned.

If a fine graduating engine, made up of many small parts, most of which have been made with the utmost possible accuracy, and which must be kept so in order to be of any value, were to go through a fire, we should say its value as a machine would then be practically nothing, and this would be the case also with any comparatively light and extremely refined machine, the proper action of which depends upon mechanical perfection of construction.

A fine universal milling machine, a universal grinding machine, a fine lathe—particularly if a small one—and most all the machinery used in watch manufacturing would certainly be ruined by fire; but we can all think of machine tools, of very indifferent original accuracy of construction, that would probably not be much hurt by fire, and there is undoubtedly a good deal of machinery used in blacksmith shops, for instance, that fire would injure comparatively little. Taking a drop hammer—such a one as is used in forge shops, for instance—and the most expensive portions of such a machine usually sustain very little damage by fire, and in some cases none at all.

A shop manager of our acquaintance exempts from his fire insurance policies his boilers, but includes the fittings and smaller parts connected to them, his opinion being that the risk of damage to boilers by fire is so small as not to be worth paying for, though, of course, gages, valves, etc., are apt to be ruined.

We think it is clear that the degree of injury that a machine will receive by going through a fire will depend mainly upon the character of the machine, though also to some extent upon the character of the fire, and the way in which water is used in putting it out. To say that every machine that has passed through a fire is useless, is a statement that seems to need some qualification.

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The Recent Steam Engine Exhibition.

The Electrical Exhibition which has flashed and glowed for a month in our neighborhood will have given many much to think of. It is not for us to speak of the Roentgen rays, or of the vacuum tubes, nor even of the actual transmission of power from Niagara to New York, these being the three most insistent features of the exhibition. A word should be said, however, concerning the steam engines. Except for the attenuated stream of energy which intermittently trickled from Niagara, the exhibition consisted entirely in showing what steam can do in one of its vaster fields of usefulness.

And it was an exhibition which the steam engineer might have well felt proud of. Few perhaps realize the fact that the steam engine for electrical purposes is as much a special development as is the locomotive or the marine engine. The conditions of successful service may be considered as exacting for the steam engine in the electric light or traction station as for those of either of the others, and electric service could never have been the practical and paying success that it is except for the so complete fulfillment of those conditions. High speed, the ability to run continuously, closeness of regulation, and with it all an economical use of the steam, have all been marvelously complied with. As an exhibition of a special type of steam engine, and of what it can do, the Electrical Exhibition just closed was a notable success.

This may all be said without a suggestion of invidious comparison. Of a dozen engines in operation, it would have been difficult for anyone to say that any one of them was decisively inferior or superior to any other; and if the number had been increased to one hundred, as it easily might have been if all the leading builders had exhibited, the same remark would have held good. While the excellence of the engines was remarkable, the uniformity of excellence was none the less so.

If there is any probability that the steam engine is soon to be superseded, there should be some tangible evidence of it forthcoming, or there should be some slackening of the silly talk upon the subject. Nowhere in the world, probably, would it have been more proper to have sought for some hint of the coming revolution than at the Electrical Exhibition; and there was not a whisper of it there. Electricity may indeed stream direct from the coal pile before the pile is all burned up; but no man living may yet say how or when.

Even the oil engine or the gas engine—rather strangely, when they have been of late such braggarts—failed to put in an appearance as a driver of dynamos. The opportunity was certainly an inviting one, but evidently not such a one as they are ready to accept.

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Education and Invention.

We publish in another column some extracts from an editorial on the above subject, which we find in the columns of "The Engineer," London. While we are not prepared to go the length of our distinguished contemporary in this matter, there are undoubtedly many grains of truth in its statements. Granting the facts, it seems to us that there is a better explanation of them than the one given.

We, no more than our contemporary, believe in the universal potency of education. In the nature of things, it can be given to but few to be great inventors, and he in whom the divine spark resides is largely independent of formal education or training. So long as the great majority are not possessed of higher education (in the usual meaning of that term), it will naturally follow that an equal majority of great inventors will be of the comparatively uneducated class. It is, however, too common to assume that because an inventor is without the formal education of the schools, that he is therefore uneducated. On the contrary, the facts often are that he is in reality educated far beyond anything given in the schools—whose courses are of necessity adapted to the wants of the average man, and not to those of the exceptional genius.

We do not believe that in the best minds the effect of scientific training is to lead to the belief "that there is nothing left to discover." As a professor of science recently remarked in our hearing: "It is only the ignorant who talk of the extent of our knowledge. The fact is that the little we know serves to show how much

we do not know, and what vast and almost unexplored fields of research lie before us." To a second-class mind the effect of scientific training is very likely to be in accordance with our contemporary's description. Scientific education consists largely of the study of precedent and the formulation of experience, and this a mind of this class may easily come to look upon as cut, dried and finished.

A conspicuous illustration is the battle that was waged about the discussion of the merits of the compound engine twenty years ago. The conservative element insisted that, with the same pressure and degree of expansion, the range of temperature was the same in simple and compound engines, and that therefore the degree of economy must be the same in both—entirely ignoring the fact that the simple engine did not realize the economy due to its range of temperature, and that the purpose of compounding was to diminish the losses. To such a mind a knowledge of the difficulties ahead undoubtedly acts as a deterrent against attempting those problems whose solution depends upon a sublime disregard of precedent, but those problems are the very ones which such a mind should let alone in any event, so that good and not harm is done in this direction, while in the humbler sphere of everyday designing, constructing and testing, this same mind is equipped for work which it could not otherwise attempt.

While, therefore, we do not admit that formal scientific education is a hindrance to a mind of the first order, we are ready to admit that to such a mind it may be of little or even no advantage. To all others (who constitute the vast majority) there can be no doubt of its great assistance.

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Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(109) E. C. H., Ithaca, N. Y., asks if the expression "underground trolley" is a correct use of language. A.—The "trolley" is properly the contact wheel used in connection with the overhead conductor system. With the underground system the connection is by a sliding contact, and, consequently, the expression "underground trolley" is, strictly speaking, a misnomer. In the public mind, however, the word "trolley" has become associated with the electric conductor system as distinguished from the storage battery system. The expression "underground trolley," therefore, really distinguishes the location of the conductor, and has doubtless come to stay in spite of its being a name descriptive of what has no real existence.

(110) J. H. C., Albany, N. Y., asks: If the cones of a bicycle bearing are on an angle of 45 degrees, and a load of 100 pounds (everything included) is placed on the axle, what will be the aggregate pressure at the point of contact on the cones? In other words, what will be the wedging of the balls against the cones? A—We do not think the actual pressure on the balls can be calculated. In addition to the angle of the cones, comes the varying angle through which the pressure is applied on each ball, as seen endwise of the shaft, and back of this comes the question of the fit between the balls and cones. If there was absolutely no shake, the pressure would be distributed among all the balls above the center; but with some shake, which there must be in practice, the balls near the horizontal center line cannot feel the vertical pressure; and how many would thus be relieved is a question depending upon how much shake there may be.

(111) L. C. S., Omaha, Neb., writes: I am looking for some information about balancing for high speeds. We have Bowsher's balancing ways, and get good standing balances; but when we put armatures, for instance, in the machine we find them more or less out of balance when running. We expect to have to balance some separator bowls, such as are used in creameries, and which run at about eight thousand turns per minute, which would be a fine job of balancing. A.—We happen to know quite intimately the practice followed in balancing the baskets of hydro extractors or centrifugal machines in one of the principal establishments devoted to their manufacture. The practice followed there is that of continually trying balancing pieces of different weights and in different positions, until the conditions are found which result in smooth running. After the size and position for the required balancing piece are determined, a piece is got out and riveted on in the place indicated. This would seem to be a rather crude practice, but is superior to the calculus for the purpose, and takes but a short time when a man is expert.

(112) A. E. J., Watrousville, Mich., gives formulæ for finding the mean effective pressure due to isothermal and adiabatic expansion, and asks if they are correct. A.—Your formula for isothermal expansion, namely,

$$M\,P = P\left(\frac{1 + 2.3 \log. \; r}{r^{1.0}}\right)$$

gives the theoretical mean forward pressure, from which the back pressure must be deducted in order to obtain the theoretical mean effective pressure. It is understood that P is the absolute initial pressure, and r the ratio of the volumes or of the absolute pressures. For adiabatic expansion of steam the formula is

$$M\,P = P\left(10\,r^{-1} - 9\,r^{-\frac{10}{9}}\right)$$

which again gives the theoretical mean forward pressure, from which the back pressure must be subtracted to obtain the mean effective pressure. P is, as before, the absolute initial pressure; but in this case r is the ratio of the volumes, not of the absolute pressures. Referring to your second question, for a method of removing corroded spots on drawing instruments, caused by common writing ink, we know no method other than to grind them out.

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Business Specials.

Transient Advertisements 40 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Adding Machine. Grant: see page 26.

Forming Lathes, Mer. Mach. Tool Co., Meriden, C.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Honest Mach. Oils. F.S. Pease Oil Co., Buffalo, N.Y

Bevel gears with planed teeth. Boston Gear Wks.

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Aluminum and Brass Castings, Machinery, Name Plates. Twining Campbell, Paterson, N. J.

Marine Iron Works, Chicago, builders of steam yachts and marine machinery; catalogs free.

Presses and dies for bar and sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Just Issued—Catalog 8. No. Mailed free. Clayton Air Compressor Works, 28 Cortlandt st., New York.

Practical Guide for Firemen, by Wakeman; 80 pp.; 75c., post free; Am. Indus. Pub. Co., B'port, Ct.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Key Seaters for any length of hub or width of keyway. New, handy machines. Mitts & Merrill, 913 Tilden street, Saginaw, Mich.

Form'g and reliev'g lathes for back'g off formed cutters; gear cutters for cutting 2 teeth at a time, any pitch, 2 to 48. R. M. Clough, New Haven, Ct.

Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

For Sale or Rent—Foundry and Machine Shop with additional land; in good condition and well equipped for medium heavy work. Capacity of foundry, seven tons per day. Located on railroad within eight miles of New York. Terms easy. Call or address, Room 41, 22 William st., N. Y.

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Machinery Prices and Machine-Shop Management.

BY W. H. CHAPPELL.

I have noticed the article in the "American Machinist" referring to the low prices for machinery, and also the case cited of the large concern which was overworked to fill local and foreign orders, yet unable to realize any profits.

This looks like a peculiar state of affairs, to say the least, and yet not an uncommon one. I am in accord with the sentiment expressed by the editorial in the "American Machinist," that "no form of Government could possibly help such a shop under the circumstances." I don't believe that, primarily, politics have anything to do with the prices of machinery. It seems to me that prices for machinery are always going down. Bicycles, sewing machines, etc., can be had for half what they cost ten or fifteen years ago; and politics don't seem to have had much to do with it. Machinery prices can't go up; it's against the laws of progress; there are too many who are constantly developing new tools and methods for cutting the cost of production.

You put in a new tool to reduce time on your work. We bid on a job; I lose it. Next time I put in a better tool, and know I can discount you two per cent. and still live. You, thinking you have the world by the tail, stick to your former price and never touch the next job we bid on. Next time we meet uptown, we talk of how prices have gone to the devil.

Several years ago, when times were good, I chanced to step into a shop where they made a specialty of cast-iron pipe fittings. The foreman was facing off the ends of a 10-inch cast tee in a 32-inch lathe. Took him a half-hour's hard

work; said that they had to work pretty hard to get a cent out of the business. Since then I saw the same piece faced, both ends at once, by a double-spindle milling machine in another shop, in less than three minutes. Didn't hear any kicks about low prices in that shop. Charge that to good equipment. Probably at some previous date this latter shop had disposed of its out-of-date tools to some competitor and put in new ones; thus gaining years in the race and ridding itself of its competitors as effectually as though it had sold them poisoned pie.

Another shop bought a Gisholt lathe to help them reduce cost of part of their work. This lathe was run six years on pieces which took five hours each to finish. Not a hundred miles away, in the shop of a competitor, the same pieces were being finished in the same lathe in one and a quarter hours. You can charge that to supervision. The only way to know "where you are at" is to know what others are doing.

Another case: In a shop where they built engines they made their own governors, the balls of which had a band, say, ¼ inch wide, ⅛ inch high, cast around them for fancy work. As they had no special machine for finishing them, they were turned and finished in a lathe; could not be finished rapidly by a circular rest on account of this flat band, which required a parallel cut over its top and a finish at the sides and corners, independently of the ball surface. Took a man four hours, as they ordinarily worked, to finish a 5-inch ball. Scraping and polishing cost $1 apiece.

Another shop, which also finished their governor balls, cast them smooth, and a man buffed them up on polishing wheels; cost about five cents. There is where machine design comes in. Charge that to the drawing-room.

I have worked in a shop where they had an enormous amount of flat surface planing on heavy work, and where they had kept from six to fifteen or more planers going for years. How much money have they lost by planing this work in the last ten years, say, which they could have saved by using an enormous and powerful rotary planer or milling machine—one having a head, say, 7 feet diameter, with cutters 2 inches apart; power enough applied to carry a cut ¾ inch deep with $\frac{1}{16}$ inch per tooth feed? Such a machine could have been built in their own shop—drawings, patterns and all—for less than $5,000, and would have done more work of this class in a week than six planers would do in a month.

There is too little boldness and prompt action about some shops; they "tinker" along in the old way until they become affected by "dry rot," as the "American Machinist" expressed it in some issue several years ago. After they get behind in the race, they will either die out or change hands, and make a desperate struggle to catch up with the world. I heard it expressed the other day that a machine shop must be run like a livery stable: Carriages must be kept clean, attractive and comfortable; horses, when showing signs of decay, must be replaced, etc., etc.

A shop without any work is in a bad fix, and its owner can be reasonably justified in "cussing" the Administration, or anything else he happens to run up against; but a shop full of work, unable to realize any profits, needs something besides a change of politics.

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To Test Coiled Springs.

In connection with the valuable article upon Coiled Springs, by Prof. E. T. Adams, of Sibley College, Cornell University, we are permitted to make the following announcement:

Any engine builder or manufacturer who will send a line of springs to be tested, paying freight both ways, will receive a record of the test of each spring furnished by him, and also a copy of the tabulated results. The only data necessary to be furnished are the name of the maker of each spring and the net price paid.

It strikes us that this is a remarkable offer, and a valuable opportunity for those interested. Sibley College gives the use of its laboratories and apparatus and does the work, Professor Adams volunteers his time and labor, and it brings no money, directly or indirectly, to either.

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Markets of Greece for American Machinery.

The present business relations between the United States and Greece are very insignificant, and it is a much to be regretted fact that American manufacturers have totally overlooked that country, leaving it to the British and German manufacturers, who are at all times in advance of Americans when it comes to the subject of pushing the markets for their manufactured goods.

The annual importations from Great Britain of steam and gas engines, pumping plants, milling machinery, machine tools, printing and lithographic machinery, cotton and wool spinning and preparing machinery, are valued at not less than $350,000, and Germany follows a very close second.

While American manufacturers of machine tools are leaving this market practically unnoticed, German manufacturers are imitating us as closely as possible in design, though they cannot compare in quality, and are placing these goods on the Grecian markets as "American."

The only drawback is the difficulty in arranging terms of payment, and the total absence of agents or representatives of American firms to push sales. The terms in vogue among British manufacturers are one-third cash with order, balance on arrival of goods against bills of lading through their agents; and to good firms four months credit. The terms granted by German manufacturers are one-fifth cash; balance by three, six, nine, and twelve months acceptances payable in Greece.

There should be a large importation from the United States in the following lines, viz.; hardware, locks, lock furniture and ironmongery goods; while, as a matter of fact, there are really none at all, the trade lying wholly with Germany and Great Britain, and is valued at over $1,000,000 per annum.

Under existing circumstances the balance of trade, so far as the United States is concerned, is largely in favor of Greece, the exports for the year 1893 being $514,000, while during the same year our imports from that country were valued at $1,083,290. During the years of 1893 and 1894 the Grecian imports of metals, unwrought, increased from $1,453,174 to $1,794,186; while those of metals, wrought, increased from $482,616 to $602,044. Now, as an example of how our efforts to secure that market for our machinery manufacturers compare with those of Great Britain: Great Britain supplied $11,678 of arms and ammunition; we none. Do they manufacture any better arms and ammunition in Great Britain than we do? Their exports of hardware and cutlery for the same year to Greece were valued at $23,357, while we exported none. Their machinery exported during the year was valued at $141,600, while we shipped them not a single dollar's worth. Their exports of iron and ironware were valued at $191,207. Where were we? In fact, during the year 1894 the only direct exports from the United States to Greece were mineral oils to the value of $123,563, and of "all other goods" $886.

True, it may seem that under existing conditions the market of Greece may appear to be off what are known as the easy highways of commerce, and the market may seem too small to warrant the effort; but if it is not too small or too difficult for our neighbors across the brine, why so for us?

▲ ▲ ▲

Help Wanted.

Situation and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our subscription list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Practical mechanic, theoretic education desires to change. Address Mechanic, care AM. MACHINIST.

Mech. Drfst., 4 ys' exp. on gen. mach., tech. grade, wishes change, N.Y. or vicinity. Box 154, AM. MACH.

Planer hand wants position; accustomed to large or small wk.; rapid, accurate. Box 145, AM MACH.

Wanted — Good draftsman desires position. Good references. 4 yrs' experience in office work. Address, Harry Gerald, Box 54, Marlenville, Pa.

Wanted—Tool-makers for screw mach. & punching presses. State age, experience and reference. Address, S. M. A., P. O. Box 1125, Boston, Mass.

Wanted—Position as draftsman by young man having had great experience in designing and building special tools. Box 133, AM. MACHINIST.

Wanted—A position by a foundry foreman, 10 yrs' experience on machinery and general jobbing. Good reference. BOX 153, AMERICAN MACHINIST.

Wanted—By a first-class machinist & draftsman, position with growing concern, as foreman or asst. supt. Best references given. Box 148, AM. MACH.

Position wanted by pract. mach. & tool maker, experienced in handling men and making piece work prices. West of Pittsburg pref. Box 149, AM. MACH.

First-class designer and draftsman, educated at a celebr. tech. college (Germany). Exp. in all sorts machine construction. Box 156, AMER. MACHINIST.

Wanted—Foreman for boiler shop; must be temperate, a good manager and competent to lay out work; about 25 men employed. State experience and wages expected. Box 130, AM. MACHINIST.

A machinist, 6 years' experience, wishes position as adv. apprentice, with best work, under practical man, served 2 yrs' app., can make expert mach. in 2 more years. Address, Box 150, AM. MACHINIST.

Wanted—Superintendent for foundry and machine shop, one conversant with medium to heavy machinery, and preferably with a knowledge of heavy electrical apparatus. Box 136, AM. MACH.

Mechanical engr. (Scotchman) wants situation, exp. in power presses and dies, rock drills and stone-working machinery, also general engineering work; has had charge. Address Box 132, AM. MACHINIST.

Wanted—Working foreman for foundry, running 10 men; must be a good molder and understand mixing and melting both iron and brass and be a man of steady habits. State experience and wages expected. Box 129, AMERICAN MACHINIST

Wanted—By a first-class machinist and d'ftsman, a position with a growing concern, as foreman or assistant superintendent; am now general foreman in engine shop, but wish to change. Best of references given. Box 124, AMERICAN MACHINIST.

Mechanical engineer, 25 years, exp. as foreman, supt., draftsman and designer in general and special machinery, wants similar position. Chicago preferred. Best of references. Address, Mechanical Engineer, 1074 N. Francisco ave., Chicago, Ill.

Wanted—Position by American technical graduate, yrs.' exp. designing and building tools, engs., cranes and gen. machy.; familiar with shop work can show good habits, ability, accuracy and attention to business; references. Box 137, AM. MACH.

Situation wanted, as constructor, by mech. eng. (29 y.) 8 yrs' pract. exp., good in thermodynamics, spec. ice mach., refrig. & steam eng. Has studied gas & pet. motors, elect. & is quite able in statical calculations. Best of refs. Box 152, AM. MACH.

Wanted—First-class designer and pattern maker, also A1 machinist. Competent men can have steady employment and good pay. Must be experts and willing to work. Location in the west.
Address, Box 155, AMERICAN MACHINIST.

Mechanical engineer and draftsman with 18 yrs.' experience on structural iron and steel wrk., steam plants, boiler and gen. construction work, desires engagem't; comp't at design'g, estim'g and cont'g, or would superintend construction, erection or shop work. Address Ajax, care AM. MACHINIST.

Wanted—An assistant superintendent, moderate size Corliss and plain engine-building bus., vicinity New York; New Englander or up to date westerner pref., who can show costs as testimony ability to turn out good wrk. cheaply; com. absolutely confidential; give experience. Box 135, AM. MACHINIST.

A superintendent. A technically educated, practical machinist and draftsman, familiar with building high speed engines, making parts interchangeable by rapid process work. Must be good manager and willing to take off and hang up coat, and hustle out work. The right man can grow. Address, giving full outline of experience and references,
BOX 151. AMERICAN MACHINIST.

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Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Callpers & Gauges. F. A. Welles, Milwaukee, Wis.

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden st., Saginaw, Mich.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O.

Bicycle manufacturers, do you desire a good opening for a branch in Canada? Address, Manufacturer, AMERICAN MACHINIST.

We make a specialty of Shartle's patent safety set collars. Prices low and samples free. Middletown Machine Co., Middletown, Ohio.

Machine forgings to order; special facilities for doing good work quick; send for estimates. The Coulter & McKenzie Machine Co., Bridgeport, Ct.

Light and fine machinery a specialty; model and experim'tal wk. strictly confidential; draw's made and invent's perfected. Howe, 19 Gull st., Buffalo.

For Sale—Second-hand Baker pressure blower for foundry use; direct coupled to upright engine, in first-class condition. Address Ames Iron Works, Oswego, N. Y.

One 6 x 8 Ide engine, in first-class repair, made by the Harrisburg Engine Co., Harrisburg, Pa., for sale cheap. Troy Laundry Machinery Co., Ltd., Chicago, Ill.

We offer an exceedingly fine lot of first-class second-hand machinery, lathes, planers, shapers, drills, millers, screw machines, etc. Call or get list 17 B. The Garvin Mach. Co., 440 Canal st., N. Y.

Wanted—A practical machinist with $2,000, able to be foreman, will get an interest in a small machine and foundry business in Ill., been in operation a few years; prospects good; location best in the city. Box 147, AMERICAN MACHINIST.

VALUABLE BOOKS

For MACHINISTS, ENGINEERS, ELECTRICIANS, Etc.

Our catalogues of Books, on the above subjects, as well as every other practical subject, sent free to any address.

☞ See our detailed advertisements of special books in recent numbers of AMERICAN MACHINIST.

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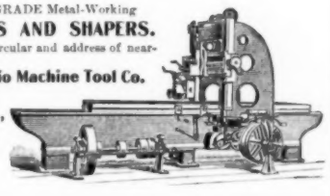
15 Beekman Street, NEW YORK.

Howard Chainless Bicycle.
The first man in any town who buys one will be allowed an agent's discount and offered an agency, whereby he gets commissions that will pay for his wheel, or at least reduce the cost. Address HOWARD, 771 Summer Av., Newark, N.J.

HIGH GRADE Metal-Working
PLANERS AND SHAPERS.
Write for circular and address of nearest agent.
The Ohio Machine Tool Co.
600 South Leighton St.,
KENTON, OHIO.



WIRE | **THE WATERBURY MACHINE CO.,**
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Owners U. S. Patents Bolton Continuous Drawing Machinery. Modern machines for drawing all kinds and sizes of wire by multiple dies.

STEEL SPIRIT LEVELS.

A wise mechanic will buy no others. Accurately ground, nickel-plated, sent post-paid for list price. Catalogue on application.

Sawyer Tool Co., Athol, Mass.

Commercial Review.

NEW YORK, SATURDAY EVENING, MAY 30TH.

Iron and Wood-Working Machinery.

"The truest thing that can be said about the situation is that it is still in a state of uncertainty," was the remark made by the New York representative of a Connecticut iron-working tool company.

Generally speaking the market appears to have become somewhat easier during the month of May. Although the machine tool trade is not one which follows the period of the year in a very definite manner, the present may be considered a between season time. There is little demand from the bicycle makers compared with what there was a number of months ago, the '96 output of wheels being about completed, and it is stated that the demand from electrical manufacturing sources is practically a thing of the past. It is difficult to forecast the future of the market. Last year, a heavy business was done in the Fall and by some parties in the Summer, which seems to have been occasioned by a temporary revival of trade at that time. This year we lack the elevating influences of the revival in iron that we had last Spring and Summer, but have the disturbing factor of a presidential election. If the large political parties should adopt similar salutary planks upon the currency question, one of the chief subjects of uncertainty would thus be settled several months before the election, and thus afford business some degree of assurance in the meantime.

There appears to be nothing to say regarding prices except that they are very low still.

The wood-working machinery market also seems easier than last month. In some parts of the country, or at least in the Southwest, it is said that there is a fair amount of demand for machinery for lumber and timber work. The heavier machinery for wood working purposes seems to sell well as compared with the lighter. We learn from the New York office of the Berlin Machine Works, manufacturers of heavy machinery, that their trade, which is for the district east of Ohio, is better for the month of May than for the same month of any year since 1892. Though a trifle less in amount than that of April, its relative significance, considering the usual record of the two months, is greater. They say that trade is naturally on the wane at this time, to resume activity about September.

The following are newly contemplated or established plants in the Southern States, reported by the "Tradesman," Chattanooga: The Richmond Wood-Working Co., Richmond, Va.; a barrel factory at Cedar Springs, Va.; a planing mill at Fairford, Ala.; a saw mill at Gulfport, Miss.; and wood-working plants to be established at Chattanooga, Tenn.; Marion, N. C.; and Fayetteville, W. Va.

The Betts Machine Co., Wilmington, Del., manufacturers of iron-working machinery, report: "Trade is still dull. We are running three-fourths of our force full time. This is somewhat of an improvement over April and over May of last year. We have considerable inquiry, but what sales we make are at as low figures as have ever prevailed." They say further that they are selling their tools mostly for electrical, street railway and railroad works.

Iron and Other Metals.

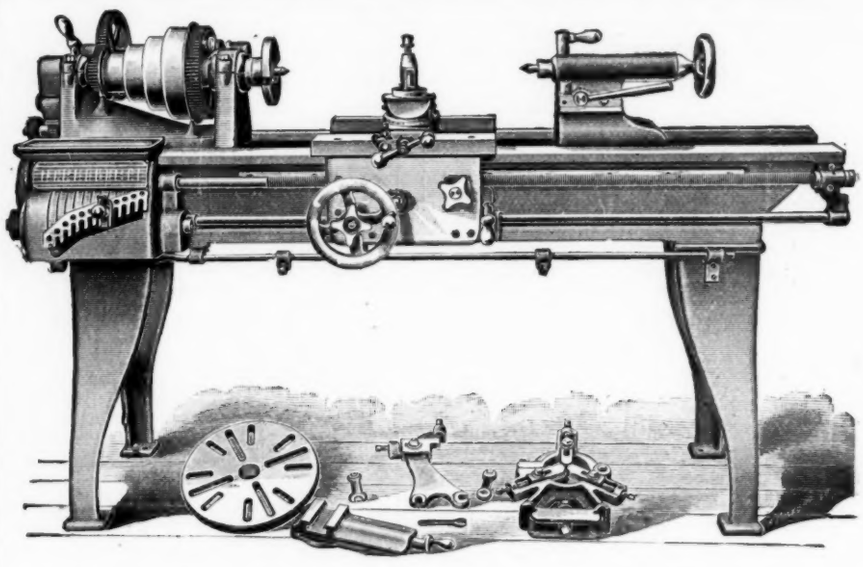
Rarely, in the history of the iron market, has it been compelled to pass through a period of greater depression than has prevailed during the month and still continues. The present tone of trade is in marked contrast to that which prevailed a year ago. How long the combinations now in operation will be able to hold out is a question. The wire nail members of the Association of Cut and Wire Nail Manufacturers, which met in Pittsburg this week, have reaffirmed their price of $2.55 per keg in carload lots, which is said to be more than $1 above the actual cost. Bar iron is weak. Many of the prices now quoted in the iron market seem to be merely nominal.

The metal market has been rather commonplace this week, except for a boom in copper, of which the climax seems already to have been attained in this country. Stiff prices are still quoted by the selling side of the market, and it is predicted that the demand will be well maintained during June. The activity is in Lake Superior and Electrolytic copper, rather than in casting stock.

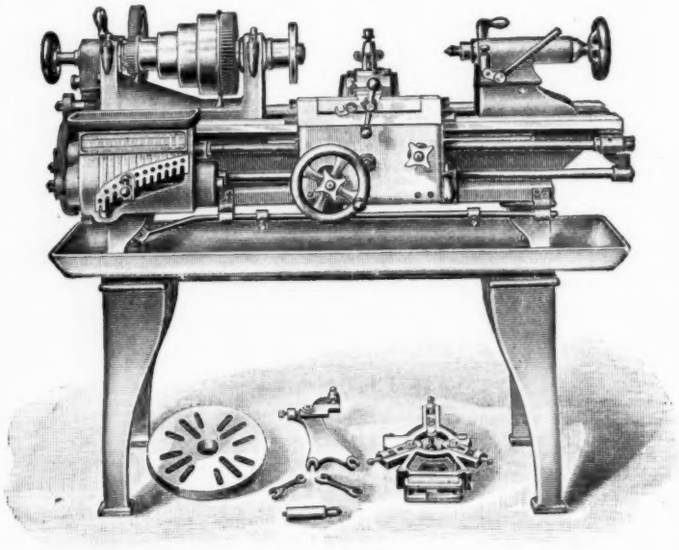
Pig tin is in about fair demand from consumers, but the speculative activity is small. An illustration of its freedom from professional manipulations this year, as compared with last, is found in the fact that, for the first five months of this year, the sales as reported upon the floor of the New York Metal Exchange have been but 965 tons, while for the corresponding months of last year they were 9,300 tons. The arrivals of tin in this country during May are stated to be 1,065 tons, and it is estimated by one authority that those for June will be more than for some months past, and close to 2,000 tons.

Pittsburg Report for May.

The iron market is still quiet, most of the sales being made by Ohio furnaces, while those in the Pittsburg district seem inclined to hold their products. The still prevailing bad feature of the market is the heavy production, which is estimated at 10,000,000 tons per annum, while the demand or consumption does not nearly reach those figures. There is considerable talk of shutting down a number of furnaces throughout this district, but as yet this has not been done. In the Mahoning and Shenango valleys several furnaces have been banked for an indefinite period.



14-in. x 6 ft. Hendey-Norton Lathe, and 12-in. x 4 ft. Hendey-Norton Lathe. These are modern, high-grade, practical tools, and are specially adapted for tool-room work. They have the Norton Attachment for screw cutting, giving 36 different threads and 36 different feeds with only two changes of gear, and movement of lever in gear box from one notch to the other. Note the automatic stop under apron. It will automatically stop carriage at any desired point in either direction. Invaluable for internal or duplicate work.



The 12-in. Lathe is fitted with drawing-in sleeve and American Watch Tool Co.'s Standard Chuck, used in making small taps, reamers, etc. Work finished first and cut from bar afterward. No centering required. See carriage reverse lever by right-hand side of apron; no reaching for countershaft shipper required.

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The Hendey Machine Co.,
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Taper 1-2 inch to foot.

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THE STORY OF A KEY-WAY—IN SEVEN ACTS.

ACT FOUR—"That don't seem to fit."

CONTINUED NEXT WEEK.

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Radial Drills, Hor. Boring & Drill. Mach'y, 18-25-30 & 36 inch Upright Drills.
FITCHBURG MACHINE WORKS,
FITCHBURG, MASS., U. S. A.
Catalog E, METAL WORKING MACH'Y.

HOR. BORING & DRILL MACH.

Prices of raw material remain about the same, foundry irons selling for $12.25 and $11.75 for Nos. 1 and 2, respectively. It is barely possible that an advance may occur. The situation is a waiting one, and no one can tell when the improvement will come. Stove foundries are well employed, preparing for the coming season.

A recent visit among some of the large and small foundries in the Shenango Valley showed that they were all pretty well filled up with small work The Witherow Works, at New Castle, are being operated, but not nearly to their full capacity. The Vulcan Foundry, at the same place, is running nearly full, and reports having plenty of orders on hand. The only complaint to be heard is, that prices are not strong enough.

In the engine and boiler lines, business has shown a marked improvement, especially for electric lighting purposes. Numerous borough, as well as private concerns, are having plants installed. The contract for the plant to be installed at Etna Borough was awarded to W. F. Patterson. For this work, there were no less than twenty-five bidders, which shows the heavy competition for such small work. The contract for the McKeesport plant will be awarded this week. It is understood that concerns from all parts of the country have placed their bids.

Machinery for water works is also in fair demand. New stations are being heard of almost daily, and there seems to be more work in this line than for some months past. A plant is to be installed at Rochester, Pa., and another at Ripley, O. The question of establishing a plant at Sharpsville, Pa., will soon be settled.

The Carroll-Porter Boiler & Tank Company, of this city, has its plant running steadily on the work recently secured at New Bedford, Mass., which will consist of eight miles of underground work. The Monroe Boiler Company is also well employed. Several new plants will be located in this district in a short time, in which boilers of many horse-power will be required. The John Dunlap Company will establish a new tin plate plant at Hays Station; the United States Radiator Company will build at West Newton, Pa.; the Conroy-Prugh Company, glass manufacturers, will build near this city, and other plants are contemplated.

The general supply trade, such as that in shafting, valves, gages, etc., is about the same as last reported. The Pittsburg Gage Company, James Bonar & Co. and Chas. A. Turner all report a brisk demand. One large contract, on which there is a great deal of competition, is that for gages, columns, etc., for the new boiler plant of 5,250 horse-power to be installed by the Cahall Boiler Company at the Edgar Thomson Steel Works. This will be one of the largest contracts of its kind let for some time.

The heater and purifier business can also be said to be active. Several large contracts have been awarded Pittsburg concerns, notably that of the Riverside Iron Works, Wheeling, for a Pittsburg feed-water heater; and also one for a Sweet separator, for the city of Pittsburg, secured by James Bonar & Co. Pumps are not in such active demand, but better business is expected soon.

In machinery such as lathes, planers and drill presses, the market seems to be improving slowly. As in other lines, there is also new work to be done. The Lloyd-Booth Company, of Youngstown, is making extensive additions to its plant and will need a large amount of new machinery. Wm. Kavanaugh & Co., of Harmony, Pa., will remove their plant to Zelienople and will be in the line of new machinery.

More improvements are contemplated than there have been for many months, and it seems that people are placing a great amount of confidence in the future.

Quotations.

NEW YORK, Monday, June 1st.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$12 50 @ $13 25
No. 2 foundry, Northern	12 00 @ 12 50
No. 2 plain, Northern	11 00 @ 11 50
Gray Forge	11 00 @ 11 75
No. 1 foundry, Southern	11 75 @ 12 00
No. 2 foundry, Southern	11 25 @ 11 50
No. 3 foundry, Southern	10 75 @ 11 00
No. 1 soft, Southern	11 25 @ 11 50
No. 2 soft, Southern	11 00 @ 11 25
Foundry forge, Southern	10 25 @ 10 50

Bar Iron—Base, in Carloads—Mill price, on dock: common, 1.10 @ 1.20c.; refined, 1.25 @ 1.50c. Store prices: common, 1.40 @ 1.50c.; refined, 1.50 @ 1.70c.

Tool Steel—Ordinary sizes, standard quality, 5¾ @ 7c.; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—From store, about 1.75. Special brands upward.

Cold Rolled Steel Shafting—Base size in carloads, about 2½c.; 2¾c. for smaller quantities from store.

Copper—Carload lots, Lake Superior ingot, 11¼c.; electrolytic, 11¼c.; casting copper, 10¾ @ 10¾c.

Pig Tin—For 5 and 10-ton lots, 13.50 @ 13.60c. f. o. b.

Pig Lead—In carloads, 3.00 @ 3.05c., f. o. b.

Spelter—In carload lots, New York delivery, 4.10c. for ordinary Western brands.

Antimony—Cookson's, 7½ @ 7¾c.; Hallett's, 6¾c.; Japanese, 6½ @ 6¾c.

Lard Oil—Prime city, present make, 45c., in car loads.

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Manufactures.

Joseph H. Junkins, Lewistown, Pa., will erect a carriage works and blacksmith shops and will put in new machinery.

The New Jersey Machine Works will open a machine and repair shop at 54-56 Morris & Essex R.R. avenue, Jersey City, N. J.

The Sharon Iron Company, Sharon, Pa., is contemplating the erection of an open hearth steel plant during the summer.

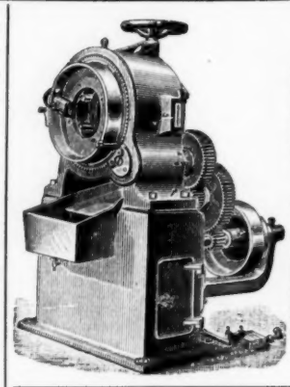
The Pittsburgh and Clearfield Mineral Mfg. Co., Pittsburgh, Pa., will erect a saw mill, and will place a line of new machinery.

The Kittanning Clay Mfg. Co., Kittanning, Pa., will engage in the manufacture of brick and tile, and will install new machinery.

Albright & Coldren, 16th and Swatarra streets, Harrisburg, Pa., will erect a steam laundry and will place the latest improved machinery.

The Reading Standard Mfg. Co., Reading, Pa., will engage in manufacturing bicycles, and will put in a new line of machinery for that purpose.

The Johnstown Shovel Mfg. Co., Johnstown, Pa., will erect a factory for manufacturing shovels and will put in new machinery. Capital stock, $25,000.



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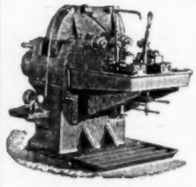

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50 cts. 2c stamps taken.
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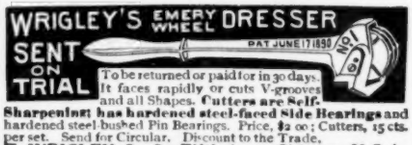

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Adjustable 2-Spindle Drill Presses
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Upright Drills.
We have a drill book, this book points a way to save money.
W. F. & JOHN BARNES COMPANY,
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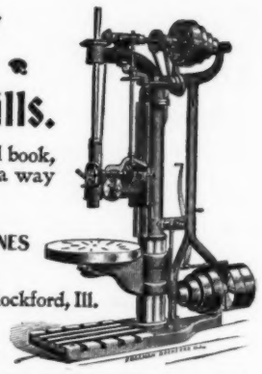
ENGLAND: Chas. Churchill & Co. Ltd., London, E. C.



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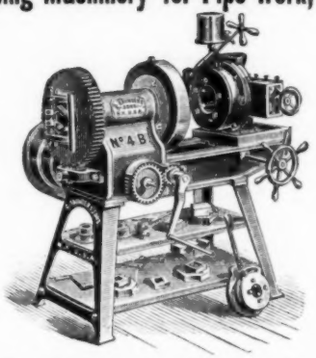

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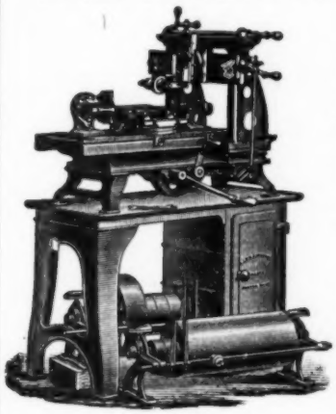

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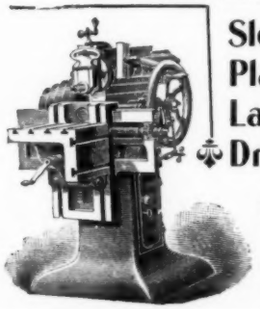

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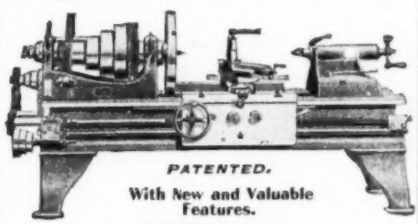

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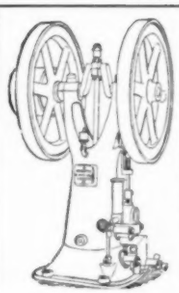

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Martin Boyer, Biglerville, Pa., manufacturer of force and lift pumps, is increasing his business, and will put in a number of special machines and a pipe and thread cutting machine.

The Pittsburgh Gas and Coke Company, Pittsburgh, Pa., has been incorporated, with a capital of $30,000. Directors, William L. Elkins, Jr., George W. Elkins, George T. Beans, Walter Cox, Arthur B. Eaton, of Philadelphia.

The Wallaceburg Gas and Oil Co., Ltd., is the name of a new company forming to operate in a new territory, with a capital of $40,000. The first directors are John Cooper and James W. Steinhoff; the chief place of business, Wallaceburg, Ont., Canada.

James McLauchlan, Thos. F. Vanstone, C. A. Fleming, Frederick Harrison, Arthur Priest, Robert Buchart, Oliver Brown, James Vair, John Reid, Wesley Owens, Michael Robinson, James Henderson and others are at the head of a $150,000 Co., recently formed at Owen Sound, Ont., Canada, to be known as the Owen Sound Sugar Mfg. Co.

The Shipway Ash and Garbage Box Co., Ltd., is the name of a new company seeking incorporation, with a capital of $20,000, to manufacture galvanized iron and sheet metals into boxes, vessels, cans, etc. Thomas Henry Shipway, Harry L. Stark, Chas. R. Shipway, are the first directors, and the chief place of business is Toronto, Ont. Canada.

A new company, known as the Lanark County Electric Railway Co., has been formed, to operate between Lanark and Perth, Ontario, Canada. The incorporators are Alex. Wendler, of Carthage, N. Y.; John B. Riley, Plattsburg, N. Y.; Thos. Henry, Montreal, Canada; Alex. H. Edwards and James Fowler, of Carleton Place, Ont., Canada. The capital of the company is $100,000.

The News Printing and Publishing Co., of London, Ont., Canada, with Messrs. Walter Wilson Evans, Geo. W. Miller, Thomas Bland, Wm. Hutchins, Geo. A. McGillivray as provisional directors, with capital stock of $20,000, are opening out as an independent evening paper on Richmond street. Premises have been secured, and a modern plant will be placed as soon as possible.

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New Catalogs.

There are three sizes of Standard Catalogs, first authorized by the Master Car Builders' Association, 9 x 12", 6" x 9" and 3½" x 6". We recommend the 6" x 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

Ott, Mergenthaler & Co., Baltimore, Md., send us a pamphlet which illustrates and describes two different types of reamers made by them.

The Oil Well Supply Co., Petrolia, Ontario, Canada, send us a well gotten up catalog illustrating and describing tools used for boring in oil, salt, gas and water wells. It also contains tables which will be found of interest to those who have to do with this class of work. The catalog contains 100 pages and is 6 x 9 inches.

▲ ▲ ▲

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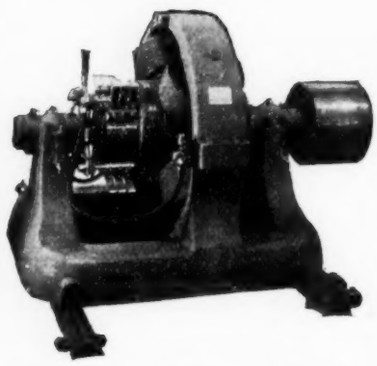

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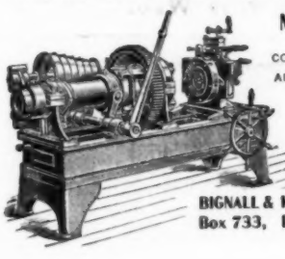

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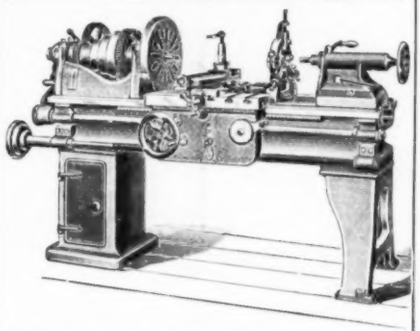

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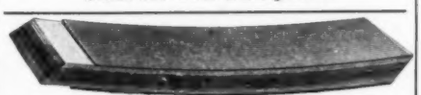

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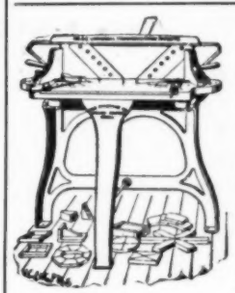

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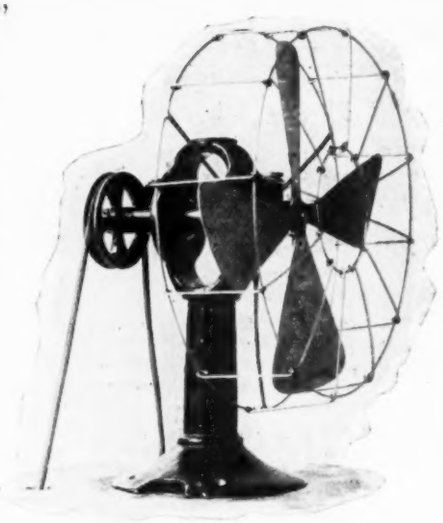

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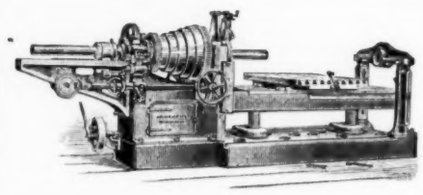

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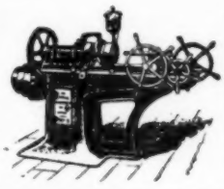

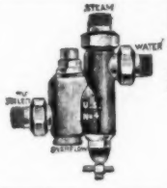

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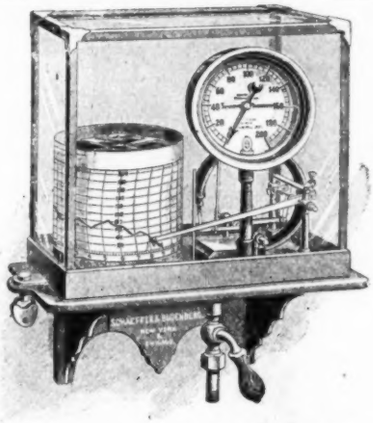

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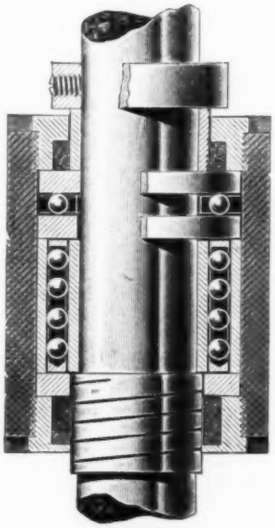

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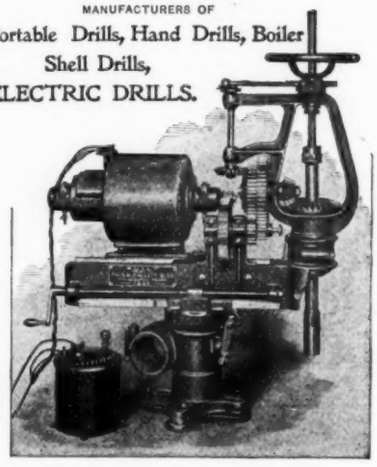

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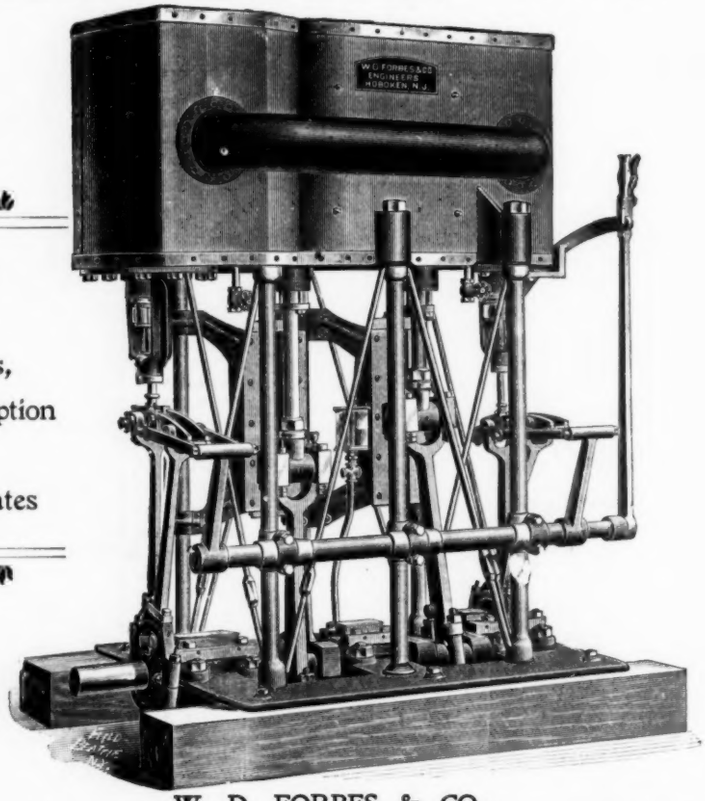

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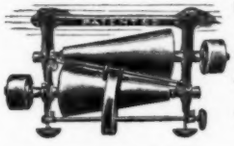

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34 in. x 20 ft., F. S. Perkins.

PLANERS.
17 in., Whitcomb, crank.
16 in. x 16 in. x 3 ft., Pratt & Whitney.
24 in. x 24 in. x 5 ft., Gray.
24 in. x 24 in. x 8 ft., Fitchburg.
26 in. x 26 in. x 6 ft., D.W. Pond.
22 in. x 22 in. x 5 ft., Pease.

SHAPERS.
6 in., Boynton & Plummer, for hand.
10 in., Hewes & Phillips, crank.
10 in., Juengst, crank.
15 in., Hendey, friction.
15 in., Lodge & Davis, crank.
15 in., Smith & Mills, crank.
15 in., Chase, crank.
16 in., Gould & Eberhardt.

MISCELLANEOUS.
1-Spindle Garvin Profiler.
25 in. Pond Drill Press.
No. 2 4-Spindle Pratt & Whitney Drill.
No. 20 Hibbard Power Press.
No. 2 Pratt & Whitney Automatic Bolt Cutter.
No. 2 Garvin Automatic Gear Cutter.
21 in. Prentice Drill Press.
No. 1 Garvin Lincoln Miller.
No. 3 Garvin Lincoln Miller.
Prentice Bros. Suspension Drill.
No. 1 Pratt & Whitney Screw Machine.
No. 13 Brown & Sharpe Screw Machine.
No. 2 Springfield Tool Grinder.
No. 2 Garvin 3-Spindle Drill.
Slate Automatic Gear Cutter.
3-8 in. Adt. Rotary Riveter.
No. 2 Diamond Polishing Lathe.
3 in. Armstrong Pipe Machine.
26 in. New Haven Drill.

Write for complete list No. 16, showing a large stock of machinery in addition to this list.

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1 13 in. x 4 ft., Ames Eng. Lathe.
1 16 in. x 6 ft., Dustin Eng. Lathe.
3 18 in. x 6 ft., L. & D. Eng. Lathe cmpd. rest and taper att.
1 19 in. x 6 ft., Fifield Eng. Lathe, heavy.
1 20 in. x 11 ft., L. & M. Eng. Lathe with Shafting tool rest.
2 21 in. x 10 ft., Pratt & Whitney Eng. Lathe with cmpd. rest and taper att.
1 23 in. x 10 ft., White Eng. Lathe with taper attachment.
1 27 in. x 10 ft., Dustin Eng. Lathe, comp. rest, heavy.
1 27 in. x 12 ft., Wood & Light Eng. Lathe, comp. rest.
1 29 in. x 12 ft., Wood & Light Eng. Lathe, comp. rest.
1 28 in. x 16 ft., Eng. Lathe, special back gear, R. & F. rest.
1 30 in. Lodge & Shipley, gear blank and pulley tur. and bor.
1 36 in. x 12 ft., Geared Eng., heavy.
1 32 in. x 13 ft., Bement & Dougherty triple Gd. S. C. comp. rest.
1 40 in. x 16 ft., geared plain turn'g.
1 48 in. x 18 ft., Gay & Silver heavy triple gear tur.

PLANERS.
1 16 in. x 16 in. x 3 ft., Hand Planer.
2 24 in. x 24 in. x 4 ft., Pond.
2 24 in. x 24 in. x 4 ft., Wood & Light.
1 24 in. x 24 in. x 7 ft., Lathe & Morse.
1 28 in. x 28 in. x 8 ft., Gay & Silver.
1 30 in. x 30 in. x 8 ft., Smith & Silk.
1 32 in. x 32 in. x 10 ft., Wood & Light.
1 32 in. x 10 ft., Open Side Planer, braced arm
1 36 in. x 36 in. x 0 ft., New Haven.
1 36 in. x 36 in. x 18 ft., William Sellers.
1 38 in. x 38 in. x 10 ft., Aldrich, heavy.
3 48 in. x 32 in. x 6 ft., Pond Planer with two heads, new, heavy pattern.

DRILL PRESSES.
6 Sensitive Bench Drills.
4 Overhead Suspension Drills, Pond.
1 10 in. two-spindle Sensitive Drill.
1 22 in. back-geared Drill.
1 34 in. back-geared Drill.
1 36 in. Gap Drill, power feed.
1 3-spindle Pratt & Whitney, adj.
2 3-spindle Sensitive, adjble.
1 Quint Turrett with tapping attachment, six-spindle.
1 4 ft. arm Radial, Hilles & Jones.

SHAPERS.
1 15 in. Crank, Kelley.
1 12 in. Traveling Head.
1 9 in. William Sellers, trvg. hd.
1 13 in. Bement & Sons, trvg. hd.
1 12 in. Hewes & Phillips, heavy geared.

BORING MACHINES.
2 No. 2, Bement & Miles, Hzl., Big. and Dg. with power elvg. att.
1 No. 2, Fedrick & Ayer Cyl. Borer.
1 30 in. Stevens Pulley Boring & Turning Lathe.

SCREW MACHINES.
1 No. 2, Pratt & Whitney, plain.
1 No. 2, P. & W. Wire Feed Oil Pump and fixtures.
1 No. 3, P. & W., f. c. hd. bk. gd., p. f. to turret slide oil pump and fixtures.
1 18 in. P. & W., Turret Head Chucking Machine, oil pump, fix. and turret tools, p. f. to turret slide.

EMERY GRINDERS.
1 No. 5, Springfield Water Tool Grinder.
1 No. 2, Leland & Faulconer Tool Grinder, two wheels.
1 No. 6, Diamond, surfacing att.
1 No. 3, Universal Cutter Grinder, Garvin.
1 No. 1, Diamond Unival. Grinder.
1 Brainard Cutter Grinder, on col.
1 P. & W. Forming Tool Grinder.

POWER PRESSES.
1 No. 95, Bliss Double Pitman.
1 No. 4, Coulter & McKenzie, single action.
1 No. 30, Bliss, single action.

MISCELLANEOUS.
1 2-spindle Profiler; Edging Mach.
1 4 in. H. & R. Cutting off Mach.
10 Bench Vises, various sizes.
1 48 in. Gear Cutter, for bevel and spur.
1 No. 1, Warner & Swasey Vertical Miller.
1 C. & C. Electric Motor, 50 K. W. Generator.
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Blaisdell & Co., P., Worcester, Mass.
Bradford Mill Co., The, Cincinnati, O.
Brown & Sharpe Mfg Co., Providence, R. I.
Bullard Machine Tool Co., Bridgeport, Conn.
Davis, W. P., Rochester, N. Y.
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Dietz, Schumacher & Boye, Cincinnati, O.
Fifield Tool Co., Lowell, Mass.
Fish Machine Works, H. C., Worcester, Mass.
Fitchburg Machine Works, Fitchburg, Mass.
Flather & Co., Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., E., Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
McCabe, J. J., New York.
McFadden Co., Philadelphia, Pa.
New Doty Mfg. Co., Janesville, Wis.
Newton Mach. Tool Works, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.
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Sebastian-May Co., Sidney, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark, John, Boston, Mass.

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Machinists' Supply Co., Chicago.
Montgomery & Co., New York.
Sawyer Tool Co., Athol, Mass.
Standard Tool Co., Athol, Mass.
Starrett Co., The L. S., Athol, Mass.

Milling Attachment.
Adams Co., The, Dubuque, Iowa.

Milling Cutters.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Erlandsen, J., New York.
Garvin Machine Co., New York.
Ingersoll Milling Machine Co., Rockford, Ill.
Leland & Faulconer Mfg. Co., Detroit, Mich.
McCabe, J. J., New York.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

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Park Mfg. Co., The, New Haven, Conn.

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Dallett & Co., Thos. H., Philadelphia, Pa.
General Electric Co., New York.
Roth Bros. & Co., Chicago, Ill.

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Abbott, Wheelock & Co., Boston, Mass.

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Jenkins Bros., New York.

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Wells, Heber, New York.

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Phosphor Bronze Smelting Co., Ltd., Philadelphia, Pa.

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National Pipe Bending Co., New Haven, Conn.

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Detrick & Harvey Machine Co., Baltimore, Md.
National Machinery Co., Tiffin, O.
Saunders' Sons, D., Yonkers, N. Y.
Wiley & Russell Mfg. Co., Greenfield, Mass.

(*Continued on page 30.*)

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Kelly & Jones Co., The, New York.

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Davis, W. P., Rochester, N. Y.
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Dawson & Goodwin, Chicago, Ill.
Detrick & Harvey Machine Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Flather & Co., Nashua, N. H.
Garvin Machine Co., New York.
Gray Co., G. A., Cincinnati, O.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co, New York.
Ohio Machine Tool Co., The, Kenton, O.
Pedrick & Ayer Co., Philadelphia, Pa.
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Screws, Machine.
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Flather & Co., Nashua, N. H.
McFadden Co., Philadelphia, Pa.
Worcester Machine Screw Co., Worcester, Mass.

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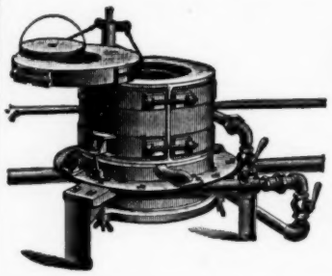
Machinists' Supply Co., Chicago, Ill.
Wells Bros., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wilkinson Co., The, Chicago, Ill.

Screws.
Cleveland Machine Screw Co., Cleveland, O.
Worcester Machine Screw Co., Worcester, Mass.

Separators, Steam.
Keystone Engine and Machine Works, Philadelphia, Pa.

(Continued on page 31.)



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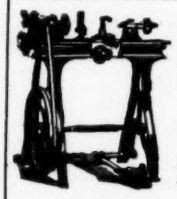

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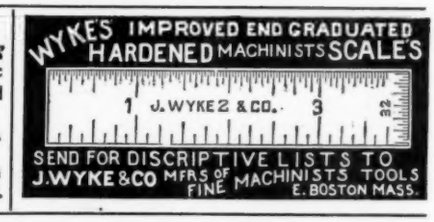
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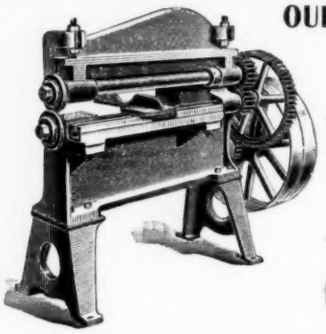

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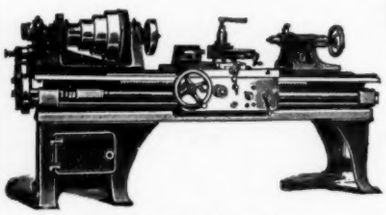

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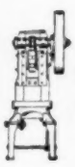

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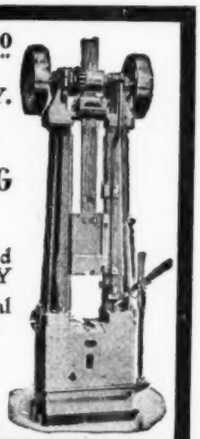

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Garvin Machine Co., New York.
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McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
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Pratt & Whitney Co., Hartford, Conn.
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Niles Tool Works Co., Hamilton, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

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Elliott Chemical Works, Newton, Mass.

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Toledo Machine & Tool Co., The, Toledo, O.
Park Mfg. Co., The, New Haven, Conn.

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Coburn Trolley Track Mfg. Co., Holyoke, Mass.

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Almond, T. R., Brooklyn, N. Y.

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Niles Tool Works Co., New York.
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Wilkinson Co., The, Chicago, Ill.
Wyman & Gordon, Worcester, Mass.

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Backus Water Motor Co., Newark, N. J.

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Goodyear, S. W., Waterbury, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Waterbury Machine Co., Waterbury, Conn.

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Pryibil, P., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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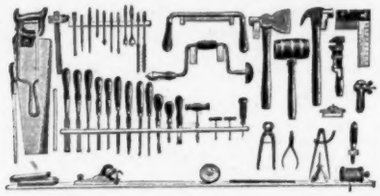

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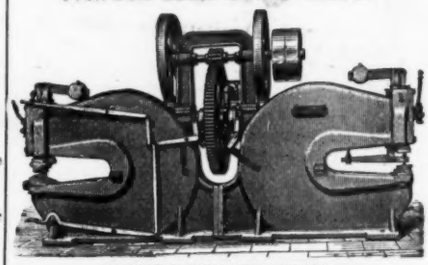

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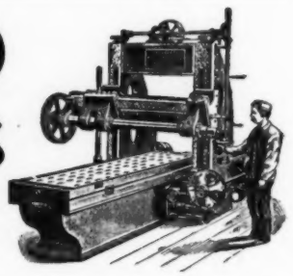

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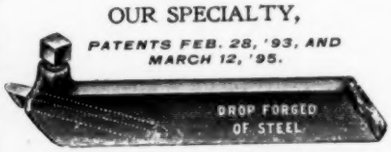

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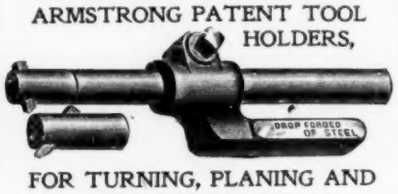

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